DOCUMENT RESUME

ED 298 141 TM 012 226

TITLE	Think about It: Volume III, Part I. A Collection of Articles on Higher Order Thinking Skills. REACH: Realistic Educational Achievement Can Happen.
INSTITUTION	Texas Education Agency, Austin.
REPORT NO	GE8-302-02
PUB DATE	Mar 88
NOTE	118p.
AVAILABLE FROM	Publications Distribution Office, Texas Education Agency, 1701 North Congress Ave., Austin, TX 78701 ($6.00).
PUB TYPE	Collected Works - General (020) -- Reports - Research/Technical (143)
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	Academic Achievement; Basic Skills; Classroom Techniques; Cognitive Processes; Educational Assessment; Elementary Secondary Education; *English Instruction; Journalism Education; *Library Instruction; *Mathematics Instruction; Problem Solving; *Reading Instruction; Research Reports; *Science Instruction; Social Studies; Writing Instruction
IDENTIFIERS	*Higher Order Skills; Texas; *Thinking Skills

ABSTRACT

Twenty-three papers on the use of higher order thinking approaches to improve basic skills education are presented. The key note article is (1) "A Case for Higher Order Thinking" (G. Garcia, Jr.). Under the heading "English Language Arts" are: (2) "Developing an Elementary Writing Program" (K. Contreras); (3) "Revision in the Writing Process" (L. van Allen); and (4) "Thinking Skills in Journalism and Speech Communication" (L. Richard). Under "Library Media" are: (5) "Thinking Experiences Are Library Experiences" (J. Kahler); and (6) "Thinking Skills and High School Libraries" (M. Boyvey). Under "Mathematics" are: (7) "Putting Computation in Its Place: Technology As a Bridge To Thinking" (C. S. Peavler); (8) "Problem Solving through Graphing" (R. J. DeValcourt); (9) "Using Geometry To Teach Problem Solving in Junior High" (B. Montalto); (10) "Thinking in Mathematics and the TEAMS Exit Test" (B. Hopkins); and (11) "Developing Thinking in the Fundamentals of Mathematics Class" (B. Montalto). Under "Reading" are: (12) "Thinking and Literature: A Plan for Prekindergarten and Kindergarten Teachers" (A. Beckett); and (13) "Thinking and Literature: A Plan for Seventh and Eighth Grade Reading Improvement" (C. Davis and M. Paulissen). Under "Science" are: (14) "Elementary Science REACHing Excellence" (B. ten Brink); and (15) "Thinking Skills and Secondary School Science" (K. Jbeily). Under "Social Studies" are: (16) "Questioning Strategies in Social Studies" (L. Grigar); (17) "TEAMS Skills in Social Studies" (D. Ketteman); (18) "Teaching Thinking in Secondary Social Studies" (E. Tyrone); and (19) "Think Citizenship!" (D. Ketteman). Under "More Thoughts" are: (20) "Thinking in Advanced Language Honors Courses: A Model" (I. Garcia); (21) "Thinking in the Fine Arts" (J. Sommer, J. Rollins, K. Wheetley); (22) "Helping Young Children Think" (A. Beckett); and (23) "Instruction and Assessment Must Match" (S. Wiedemann). (TJH)

ED298141

REACH

REALISTIC EDUCATIONAL ACHIEVEMENT CAN HAPPEN

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

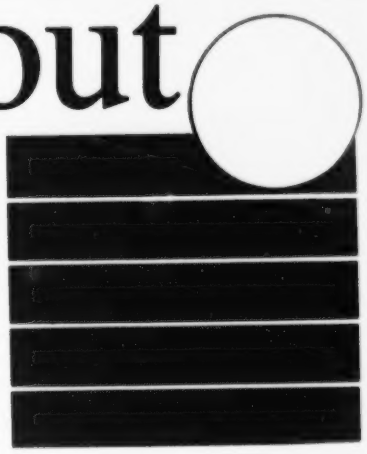
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

LINDA KEMP

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Think About It



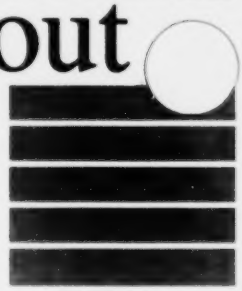
A Collection of Articles on Higher Order Thinking Skills

TM 012 226

REACH

REALISTIC EDUCATIONAL ACHIEVEMENT CAN HAPPEN

Think About It



VOLUME III, PART I

A Collection of Articles on Higher Order Thinking Skills

Texas Education Agency
Austin, Texas

Copies of this publication
are available for $6.00
from Publications Distribution,
(512) 463-9744.

STATE BOARD OF EDUCATION (STATE BOARD FOR VOCATIONAL EDUCATION)

JON BRUMLEY, Fort Worth
Chairman of the State
Board of Education
District 11

REBECCA CANNING, Waco
Vice Chairman of the State
Board of Education
District 9

EMMETT J. CONRAD, Dallas
Secretary of the State
Board of Education
District 13

Board Members

VOLLY C. BASTINE, JR.
Houston
District 4

MARY HELEN BERLANGA
Corpus Christi
District 2

CAROLYN HONEA CRAWFORD
Beaumont
District 7

CHARLES W. DUNCAN, JR.
Houston
District 6

PAUL C. DUNN
Levelland
District 15

MARIA ELENA A. FLOOD
El Paso
District 1

WILLIAM V. McBRIDE
San Antonio
District 5

GERALDINE MILLER
Dallas
District 12

PETE MORALES, JR.
Devine
District 3

JOHN MACK PRESCOTT
College Station
District 10

KATHERINE PEARCY RAINES
Cleburne
District 14

JACK STRONG
Longview
District 8

W.N. KIRBY, Commissioner of Education
(Executive Officer of the State Board of Education)

COMMITTEES OF THE STATE BOARD OF EDUCATION

Personnel
JOHN MACK PRESCOTT, Chairman
REBECCA CANNING
EMMETT J. CONRAD
CAROLYN HONEA CRAWFORD
PAUL C. DUNN

Long-Range Planning
REBECCA CANNING, Chairman
MARY HELEN BERLANGA
EMMETT J. CONRAD
CAROLYN HONEA CRAWFORD
CHARLES W. DUNCAN, Jr.
WILLIAM V. McBRIDE

Finance & Programs
MARIA ELENA A. FLOOD, Chairman
JON BRUMLEY
WILLIAM V. McBRIDE
GERALDINE MILLER
PETE MORALES, JR.

Students
JACK STRONG, Chairman
VOLLY C. BASTINE, JR.
MARY HELEN BERLANGA
CHARLES W. DUNCAN, JR.
KATHERINE PEARCY RAINES

PUBLICATION STAFF

VICTORIA BERGIN
Deputy Commissioner for Curriculum and Program Development

GRACE GRIMES
Assistant Commissioner for Curriculum and Instruction

LEROY F. PSENCIK
Director of Curriculum Development

GILBERT GARCIA
Director of Exemplary Programs

BONNIE GARRINGTON
Editor

BETTY WHITE
Director of Graphics

TRISH SMITH
Supervising Typographer

CATHERINE CANSLER SNAVELY
Typographer

COLLEEN MEUTH
Typographer

TABLE OF CONTENTS

Foreword 1

Keynote Article

A Case for Higher Order Thinking 3

English Language Arts

Developing an Elementary Writing Program 13
Revision in the Writing Process 17
Thinking Skills in Journalism and Speech Communication 23

Library Media

Thinking Experiences *Are* Library Experiences 29
Thinking Skills and High School Libraries 33

Mathematics

Putting Computation in Its Place: Technology as a Bridge to Thinking 37
Problem Solving Through Graphing 41
Using Geometry to Teach Problem Solving in Junior High 47
Thinking in Mathematics and the TEAMS Exit Test 51
Developing Thinking in the Fundamentals of Mathematics Class 55

Reading

Thinking and Literature: A Plan for Prekindergarten and Kindergarten Teachers 61
Thinking and Literature: A Plan for Seventh and Eighth Grade Reading Improvement 69

Science

Elementary Science: REACHing Excellence 77
Thinking Skills and Secondary School Science 83

Social Studies

Questioning Strategies in Social Studies 89
TEAMS Skills in Social Studies 93
Teaching Thinking in Secondary Social Studies 97
Think Citizenship! 101

More Thoughts

Thinking in Advanced Language Honors Courses: A Model 107
Thinking in the Fine Arts 111
Helping Young Children Think 119
Instruction and Assessment Must Match 123

FOREWORD

Educators not only in Texas, but across the country, are concerned about why competence in basic skills has increased so slowly since the decline of the 1970s. But the phenomenon of declining test scores has not necessarily been caused by problems with basic skills. In fact, the findings of the National Assessment of Educational Progress indicate that the greatest declines have occurred among items testing the higher level skills: analysis, synthesis, and evaluation. And, as indicated in the article in this publication titled *A Case for Higher Order Thinking*, Texas is only one among many states finding the same pattern.

There is a growing consensus among educators that something should be done to help children learn to be skillful thinkers. In a recent survey of America's rural, small schools, for example, respondents rated improving the academic performance of students from low-income families and thinking and reasoning skills as top priorities. In numerous committees, educators who were asked to interpret NAEP findings, reached these uneasy conclusions: Reading educators were pleased with the stability of results, but disappointed that inferential comprehension declined. Writing educators were generally pleased, but felt performance on many writing tasks was lower than they would expect it to be. Literature educators felt that performance on analytic, interpretive, and evaluative tasks was much lower than acceptable. Mathematics educators said the results of word problems and problem-solving exercises were much too low. Science educators were distressed to see physical science exercise results continue downward.

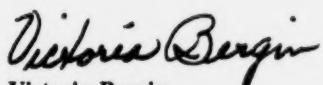
One of the many reasons Texas educators also think this way is related to the perplexing phenomenon of sluggish TEAMS scores, despite inordinate amounts of time spent by many Texas school districts preparing students for a test that should be routine. Is there a link between thinking skills and improved basic skills? Some of the research indicates there is. Other research indicates that, basic skills aside, students who are taught thinking skills learn to think better.

Many districts have already begun their own independent search for answers, implementing selected thinking skills across subjects and grades, or as separate courses. Major educational groups are endorsing teacher training programs or have begun to develop a comprehensive thinking skills curriculum. Most Texas administrators have had at least a taste of *Bloom's Taxonomy of Higher Level Thinking Skills* in leadership or teacher appraisal training.

But long before thoughtful decisions are made about how to help children learn to be skillfull thinkers, teachers and administrators in every district must answer these fundamental questions: Why should we teach thinking skills? What thinking skills should we teach our students? How should we teach them?

For the majority of educators who are eager to begin exploring how to lead their students beyond "just the facts," Volume III of REACH is intended to serve as the starting point for discussion that will eventually lead to teaching "good" thinking. Part I contains 23 articles written by staff members of the Divisions of General Education and Exemplary Programs. Many of these articles contain strategies that can be implemented in classrooms immediately. Part II will be written by staff members in vocational education and field educators. And finally, Part III will include models of thinking skills programs that have been implemented successfully in Texas classrooms.

What we think you will find in *Think About It* is this: Thinking skills have become the new "basics" of the future.



Victoria Bergin,
Deputy Commissioner
for Curriculum and
Program Development

A CASE FOR HIGHER ORDER THINKING

Written by
Gilbert Garcia Jr.,
Director of
Exemplary Programs

In the 1970s, declining college entrance test scores reported by the Scholastic Aptitude Test (SAT), the California Achievement Test (CAT), and the National Assessment of Education Progress (NAEP) led to numerous documentaries, commission reports, and other research that cited disturbing evidence of graduating high school students who were unable to read, write, or calculate at an acceptable standard. *(Casey & Christie, Jenkins in Frahm & Covington)*

Disappointing student test scores raised questions about educational standards and brought about a demand for improved instruction. These demands fueled the accountability movement—and the measurement of student achievement based on test results or scores suddenly took on a new and important role. State legislatures, boards of education, and commissions responded by recommending minimum competency testing.

Since the movement began, over forty states have legislated actions requiring various uses for such testing. Airasian and Madaus note that testing has been used for the following policy-related purposes: "assessing educational equity; providing evidence on school and program effectiveness; allocating compensatory funds to school districts; evaluating teacher effectiveness; accrediting school districts; classifying students for remediation; and certifying successful completion of high school or a given grade of elementary school." In essence, testing has become the public monitor of educational standards, assisting in the identification of weaknesses in instruction and curriculum. *(Anrig)*

Today, researchers and educators continue to probe the effects of minimum competency tests. Some

Disappointing student test scores raised questions about educational standards and brought about a demand for improved instruction.

researchers, for example, have found that focusing on individual test items or objectives, rather than on total test scores, can reveal unique and statistically significant achievement differences that are useful in school improvement efforts. *(Hanson & Bailey; Harnish & Linn; Miller; Miller & Burstein)*

This nationwide scrutiny of test scores revealed the decline of achievement in higher order thinking skills such as inference, analysis, interpretation, and problem solving. Note the findings of the NAEP:

- Of the four achievement groups, it is the top group, the highest achievers, who are showing declining scores in their overall reading performance at age seventeen;
- Two-thirds of the 17-year-olds are not doing any appreciable amount of writing in their classes;
- When asked to respond to literary works and explain their response in writing by analyzing the work, very few teenagers demonstrated strong analytic skills. In fact, only five to 10 percent of them did so. Another 35 to 50 percent showed they had an inkling of what to do; 25 to 40 percent tended to "retell" the work (summarize the plot or main idea); and 10 to 15 percent proved unable to respond;
- Seventeen-year-olds tended to move away from responses based upon inferential leaps (right or wrong) and more toward "egocentric" responses (in which they talk mainly about themselves instead of the work) and superficial evaluations;
- . . .performance on knowledge exercises remained the same or declined very slightly, but performance on problem-solving exercises declined dramatically: 5.9 percentage points at age 9; 3.4 percentage points at 13; and 4.0 points at age 17. In skills, 13-year-olds declined 2.0 percentage points and 17-year-olds declined 5.0 points.
- Post hoc analyses of the Scholastic Aptitude Test revealed that the greatest declines in that test also occurred among the items testing higher level skills.

Similar findings for ninth grade Texas students were evident in an analysis of performance results from the Texas Assessment of Basic Skills (TABS) Test, 1981-82 through 1984-85. Although my dissertation study, titled *Accountability and Assessment: A Policy Analysis of Minimum Competency Testing in Texas*, indicated that overall achievement scores were rising in the state, gains in higher order objectives were not increasing at the same rate.

In the study, data was obtained to show the number and percent of Texas school districts reporting mastery of each of the TABS mathematics and reading objectives by 70 percent of their ninth grade students. These objectives were then divided into two categories: (1) those mastered by 70 percent or more school districts, and (2) those mastered by less than 70 percent of school districts. Tables I and II list the findings:

TABLE I

TABS Objectives Mastered By At Least 70 Percent of Texas School Districts

Mathematics

	Objectives in Rank Order	No. of Districts Reporting Mastery	Average Percent Reporting Mastery
1.	Add/subtract whole numbers	955	97.8
11.	Read, interpret charts/graphs	951	97.4
2.	Multiply/divide whole numbers	945	96.8
7.	Find total dollar amount/correct change	943	96.8
10.	Determine distance/location on maps	928	95.1
5.	Use decimals	846	86.7
8.	Use measurement units	798	81.8

N = 976

Reading

8.	Follow written directions	942	96.5
10.	Use reference skills	916	93.8
11.	Use maps, charts	868	88.9
2.	Sequence events	774	79.3
3.	Perceive cause-effect	773.5	79.3
6.	Draw conclusions	742	76.0
4.	Evaluate information	722	73.9

N = 976

TABLE II

TABS Objectives Mastered By Less Than 70 Percent of Texas School Districts

Mathematics

	Objectives in Rank Order	No. of Districts Reporting Mastery	Average Percent Reporting Mastery
3.	Solve problems	630	64.5
4.	Use fractions/mixed numbers	403	41.3
9.	Use ratio/proportion/percent	147	15.1
6.	Solve personal finance problems	94	9.6

Reading

1.	Identify main idea	626	64.1
7.	Make generalizations	595.5	61.0
5.	Distinguish fact/nonfact	580	59.4
9.	Use parts of book	445.5	45.6

N = 976

The objectives listed in Table I show far higher mastery levels than those listed in Table II. Overall, most Texas school districts performed well. However, it was evident that eight of the 22 TABS objectives were not mastered consistently by the vast majority of Texas school districts. All eight objectives required higher order thinking.

The eight higher order TABS objectives noted in Table II were clustered to determine the number of school districts successfully mastering them and those most in need of remediation. Districts were divided into two categories: (1) those with at least 70 percent mastery of each objective, and (2) those with less than 70 percent mastery. Table III lists the findings:

...nationwide scrutiny of test scores revealed the decline of achievement in higher order thinking skills such as inference, analysis, interpretation, and problem solving.

TABLE III
School District Mastery of Higher Order TABS Objectives

TABS Objectives	No. of Districts Reporting at Least 70% Mastery	No. of Districts Reporting Less Than 70% Mastery
Mathematics (3, 4, 6, & 9)	12 (1.23%)	155 (15.88%)
Reading (1, 5, 7, & 9)	66 (6.76%)	89 (9.12%)
Both Reading and Mathematics	8 (0.82%)	74 (7.58%)

N=976

Only eight districts reported that at least 70 percent or more of their ninth grade students consistently mastered all eight higher level TABS objectives. In alphabetical order, these districts were: Carroll, Highland Park, Humble, Irving, Midway, Plano, Randolph Field, Richardson.

These were discouraging results. First, TABS was a minimum competency assessment and, second, the objectives students had the most difficulty mastering were those most likely to be measured by college entrance examinations.

Are Texas students adequately prepared to master such objectives? A report on 1986 TEAMS scores, compiled by the Texas Education Agency's Division of Research and Information, may provide an answer. By clustering TEAMS objectives into groups of simple and higher order thinking skills, the following table notes the percent of students who mastered them in grade 3 through the Exit Level test.

TABLE IV
Mastery of Simple and Higher Order Thinking Skills

	Mathematics	English Language Arts
Exit Level		
Simple	80.5	84.0
Higher Order	75.0	79.4

	Mathematics	Reading	Writing
Grade 9			
Simple	76.9	69.7	87.0
Higher Order	75.0	73.4	49.6
Grade 7			
Simple	80.2	81.6	80.6
Higher Order	78.5	72.3	50.8
Grade 5			
Simple	81.8	80.5	88.2
Higher Order	78.1	77.5	54.7
Grade 3			
Simple	90.3	84.4	92.1
Higher Order	91.4	81.9	53.2

*At the end of this article, Tables 5, 6 and 7 indicate the TEAMS objectives categorized as Simple (S) and Higher Order (*) for grades 3, 5, 7, 9 and Exit Level.

...it was evident that eight of the 22 TABS objectives were not mastered consistently by the vast majority of Texas school districts. All eight objectives required higher order thinking.

Of the TEAMS objectives testing higher level thinking skills, the following objectives were mastered by less than 70 percent of the Exit Level students:

Mathematics
8. Multiple Operations
9. Proportion
11. Measurement Units
17. Formulas

English Language Arts
1. Main Idea
17. Proofreading

Of the TEAMS objectives testing simple thinking skills, the following objectives were mastered by less than 70 percent of the Exit Level students:

Mathematics
5. Fractions, mixed numbers
13. Geometric properties

English Language Arts
12. Punctuation
13. Spelling

Why is it that students consistently master certain TEAMS objectives and not others? Clearly this data raises questions about instruction in some of the TEAMS simple objectives and all of the higher order objectives.

How do student achievement results affect individual campus performance? Are there campuses in the state where at least 70 percent of the students master not only the simple, but also the higher level TEAMS objectives? The data yielded these results:

Campuses Reporting
At Least 70 Percent
Mastery of all TEAMS Objectives

Elementary Campuses	299
Secondary Campuses	20
Total	319

N=Over 4,000

(Some campuses noted both elementary and secondary campuses because all grades were in one building.)

Should the educational community be concerned that only 319 out of 4,000 campuses have been able to master all of the TEAMS tests? It is, after all, a test of only minimum competencies. Has pervasive testing of lower level skills driven the time and motivation for teaching higher level skills out of the classroom? Have teachers done too much of the hard thinking for their students? Have students not been taught thinking skills or given opportunities to use them?

The TABS and TEAMS tests developed to assess the basic educational achievement of our students were never meant to hinder creativity in the classroom. Where I have observed campuses in which TEAMS results are impressive, the instructional lessons have focused on higher order thinking and TEAMS objectives have been incorporated within, but have not dominated, the lesson.

In an elementary classroom, for example, where students were reading a story, **main idea** (TEAMS) was addressed, **context clues** (TEAMS) were reviewed, and **specific details** (TEAMS) were identified, while setting, an essential element, was clearly the focus of the lesson. When the teacher offered the students an opportunity to alter the story's setting and analyze how the story would be affected by such change, the students became intensely involved. Clearly, thinking was an integral part of the lesson, and clearly the teacher expected students to use a wide array of thinking skills.

Numerous NAEP reports offer general strategies for helping teachers move beyond the basics to challenge students. Some of these strategies are:

Why is it that students consistently master certain TEAMS objectives and not others? Clearly this data raises questions about instruction in some of the TEAMS simple objectives and all of the higher order objectives.

Reading and Literature

- Stress inferential, as well as literal, comprehension skills.
- Cultivate interest in reading that will get students reading and keep them reading for longer periods of time.
- Make students write about what they read.
- Encourage students to make more than quick, superficial responses to their reading.
- Don't do all the hard thinking for the students. Let them do it. Some studies show that many writing teachers make the hard organizational and structural decisions for their students, leaving the students to fill in blanks.

Writing

- Make students write in a variety of discourse modes such as persuasion or description and for a variety of audiences.
- Recognize that teaching grammar and correcting errors are only two aspects of writing and should not be overstressed.
- Provide pre-writing training and oral and written feedback on papers.
- Require students to rewrite papers after they have been fully diagnosed.

Mathematics and Science

- Take advantage of calculators as devices students can use to check their work and as handy teaching tools.
- Do not wait until students have mastered computation skills before going on to problem solving. Both can be taught at the same time.
- Give students the opportunity to interact with one another in exploratory projects.
- Take advantage of the good will students have toward both science and mathematics. (Studies show high student interest in these subjects.)

The NAEP also notes that all of these general teaching recommendations have been tied to highly specific teaching strategies in many education publications. However, the report adds a serious comment about the implementation of "challenge" in our classrooms: "Having established a list of 'how to's' for teachers, it is necessary to establish the conditions under which they are able or unable to carry them out. The most obvious constraints are their own knowledge, their time, their other assignments, their materials and their support systems. These are all factors over which principals, schools of education, teacher accrediting agencies and other administrators can exercise control." Creating challenging classroom environments will require support on many fronts.

Teachers at some of the 319 campuses that mastered all TEAMs objectives offer the following suggestions for teaching the thinking skills included in TEAMS and, in general, teaching students to think:

- TEAMS should be incorporated into the curriculum, but not dominate the curriculum.
- Activities requiring critical thinking should be developed for each TEAMS objective. When appropriate, timelines can be implemented to help pace instruction.
- Teachers should be trained in thinking processes and incorporate them in daily instruction.
- Staff development should be scheduled frequently in the broad area of thinking.
- Teachers should guide student responses and allow ample time for thinking before they respond.

Should the educational community be concerned that only 319 out of 4,000 campuses have been able to master all of the TEAMS tests? It is, after all, a test of only minimum compentencies.

- Students should be challenged in a positive and non-threatening manner. Ask students to think of many varied and unusual ideas, and to add to these ideas.

Readers of this publication will also find numerous references to current research in thinking and strategies for teaching thinking skills. Bloom's Taxonomy of Educational Objectives, illustrated on page 124, provides a framework for thinking, and examples of how to use the taxonomy appear in most articles.

Conclusion

The analysis of individual TABS or TEAMS objectives, rather than the total test score, reveals differences in student achievement that are important to the teaching of higher order skills. The data presented in this article support the probability that many campuses or entire districts provide consistent, concentrated instruction in certain identified TEAMS objectives, while many objectives requiring higher level thinking are neglected.

It is my hope that teachers and administrators will analyze their assessment results by objective for the past five years and determine if substantial gains have been made in higher order objectives. Effective student performance rests with the educators who direct daily instruction in the classroom and who have the greatest opportunities to affect student achievement.

TABLE V
Mathematics

TEAMS Objectives	Grade 3	Grade 5	Grade 7	Grade 9	Exit Level
1	S	S	S	S	S
2	S	S	S	S	S
3	S	S	S	S	S
4	S	S	*	*	S
5	S	S	*	*	S
6	S	*	S	*	S
7	S	*	S	*	S
8	*	*	S	S	*
9	*	S	*	S	*
10	S	*	S	*	*
11	S	S	S	*	*
12	N/A	N/A	N/A	N/A	*
13	N/A	N/A	N/A	N/A	S
14	N/A	N/A	N/A	N/A	S
15	N/A	N/A	N/A	N/A	*
16	N/A	N/A	N/A	N/A	*
17	N/A	N/A	N/A	N/A	*
18	N/A	N/A	N/A	N/A	S

* = Higher Order
S = Simple

Reference List:

Airasian, P. & others. 1978. Policy Issues in Minimal Competency Testing and A Comparison of Implementation Modes. *American Journal of Education.*

Anrig, G. 1985. Educational Standards, Testing, and Equity. *Phi Delta Kappan, 66,* 623-625.

Casey, J. & Christie, S. 1983. Heading Off Legal Challenges to Local Minimum Competency Programs. *Educational Evaluation and Policy Analysis, 5,* 31-42.

Frahm, R. & Covington, J. 1979. What's Happening in Minimum Competency Testing. *Phi Delta Kappan,* 6-51.

Hanson, R. & Bailey, J. March 1982. Identification of Instructionally Sensitive Items. Paper presented at the Annual Meeting of the National Council on Measurement in Education, New York City.

Harnisch, D. & Linn, R. 1981. Interactions Between Item Content and Group Membership on Achievement Test Items. *Journal of Educational Measurement. 18,* (2), 109-118.

Lessinger, L. 1970. Engineering Accountability for Results in Public Education. *Public Delta Kappan,* 52, 217-225.

Linn, R. & others. November 1982. Minimum Competency Testing: Cautions on the State of the Art. *American Journal of Education,* 1-35.

Miller, M. 1981. *Measuring Between Group Differences in Instruction.* Unpublished doctoral dissertation, University of California, Los Angeles, CA.

Miller, M. & Burstein, L. April 1980. The Utility of Multilevel Methods for Analyzing and Interpreting Achievement Test Data. Paper presented at the Annual Meeting of the National Council on Measurement in Education, Boston, MA.

Education and Learning to Think. 1987. Committee on Mathematics, Science, and Technology Education, Commission on Behavioral and Social Sciences and Education National Research Council. National Academy Press, Washington, DC.

TABLE VI
Reading

TEAMS Objectives	Grade 3	Grade 5	Grade 7	Grade 9	Exit Level
1	*	*	*	*	*
2	S	*	*	S	*
3	*	S	S	S	S
4	S	S	S	S	S
5	S	*	*	*	S
6	S	*	*	*	*
7	S	*	*	*	*
8	*	S	S	S	S
9	S	S	S	*	S
10	N/A	N/A	S	S	*
11	N/A	N/A	N/A	S	S
12	N/A	N/A	N/A	N/A	S
13	N/A	N/A	N/A	N/A	S
14	N/A	N/A	N/A	N/A	S
15	N/A	N/A	N/A	N/A	S
16	N/A	N/A	N/A	N/A	S
17	N/A	N/A	N/A	N/A	*
18	N/A	N/A	N/A	N/A	*

* = Higher Order
S = Simple

TABLE VII
Writing

	Grade 3	Grade 5	Grade 7	Grade 9	Exit Level
Objectives	S	S	S	S	S
Composition*	*	*	*	*	

* = Higher Order
S = Simple

For Further Reference:

Carpenter, T. & others. 1981. *Results from the Second Mathematics Assessment of the National Assessment of Educational Progress*. Reston, VA: National Council of Teachers of Mathematics.

Garcia Jr., G. 1986. *Accountability and Assessment: A Policy Analysis of Minimum Competency Testing in Texas*. Ph.D. dissertation, University of Texas.

National Assessment of Education Progress. December 1982. National Assessment Findings and Educational Policy Questions. Denver, CO: NAEP.

_____. 1982. *Reading Comprehension of American Youth: Do They Understand What They Read?* Denver: Education Commission of the States.

_____. 1982. *Reading, Science and Mathematics Trends: A Closer Look*. Denver: Education Commission of the States.

_____. 1981. *Reading, Thinking and Writing*. Denver: Education Commission of the States.

_____. 1981. *Three National Assessments of Reading: Changes in Performance, 1970-1980*. Denver: Education Commission of the States.

Texas Education Agency. 1983. *Texas Assessment of Basic Skills Statewide and Regional Results*, September 1983. Austin, TX: Texas Education Agency.

_____. 1985. Texas Assessment of Basic Skills Report for 1985: Vol. I. State and Regional Results, November 1985. Austin, TX: Texas Education Agency.

_____. 1986. Texas Educational Assessment of Minimum Skills Student Performance. Results for 1985-1986. Austin, TX: Texas Education Agency.

ENGLISH LANGUAGE ARTS

REALISTIC
EDUCATIONAL
ACHIEVEMENT
CAN
HAPPEN

DEVELOPING AN ELEMENTARY WRITING PROGRAM

Written by
Kaye Contreras,
English Language Arts Specialist

Writing is a process that involves much more than exercising a set of previously learned and practiced subskills. It requires the simultaneous conversion of an idea to language and then to graphic symbols. It involves planning, remembering, choosing, spelling, ordering, and the physical act of writing, all at one time. In writing, as in solving problems, students sift irrelevant information, connect facts in a meaningful way, link new information to what they already know, and try to resolve discrepancies. Students also must select, arrange, and organize material in a way that fits the reader's needs and the constraints of prose.

Written expression, by necessity, involves higher order thinking. A single composition may require the writer to personalize, reflect, relate, project, and invent. In addition, different types of writing demand different types and levels of thinking; therefore, to produce compositions, students must be able to manipulate ideas in varying ways. Explaining relationships within a set of data, for example, is a more complex operation than recalling what one has heard. Developing a thoroughly reasoned judgment is more difficult than stating a simple opinion. Writing helps students learn to organize and clarify their thoughts. So when teachers emphasize writing, they are emphasizing thinking.

Written expression, by necessity, involves higher order thinking. A single composition may require the writer to personalize, reflect, relate, project, and invent.

Students must be taught how to produce well-developed pieces of writing. The most effective approach for reaching this goal is to implement a campuswide writing program encompassing all subjects. Participants in the program should view teaching thinking and writing as a developmental process in which students are provided cognitive activities that build on previous ones and are slightly more complex than those experienced earlier.

There are four key components in an effective writing program: staff development, a comprehensive approach, administrative support, and classroom instruction. Each of these components is discussed below, along with additional points for consideration.

Staff Development

Staff development, bolstered by periodic updates, is an essential part of a successful writing program. Administrators across the nation who currently use this approach generally do not insist on mandatory attendance. Rather, they begin with volunteers, assuming that the testimony of these teachers, along with improved student writing, will convince other teachers to participate.

Individuals from both inside and outside the district should be used as staff development trainers. The use of outside consultants reduces the amount of guesswork and trial-and-error tactics that can occur in developing a new program. Presentations should focus on the practical application of writing techniques to the curriculum and appropriate writing stimuli in the elementary grades.

Other considerations for coordinating staff development activities include:

- Informing teachers of current research in teaching writing
- Focusing on specific skills in which teachers may be weak
- Giving teachers the time and opportunity to gain confidence in teaching composition and allowing structured feedback about their use of new skills
- Providing teachers with opportunities to observe other classrooms
- Addressing issues such as paperwork, evaluation of compositions, diagnosis and remediation of student writing, and approaches for explaining the writing program to parents
- Involving administrators in both program and inservice activities
- Providing presentations that include many hands-on activities

A Comprehensive Approach

Districtwide assessment of student writing is one of the best ways to start or improve a writing program. Such an assessment focuses all teachers and students on writing. Providing samples of student writing for teachers to examine calls attention to the variety of needs that exist among students. Administrators should survey staff members to determine the extent of student writing currently required by teachers.

In successful writing programs, writing is not viewed as a separate subject, but rather as a part of all subjects. This approach can be encouraged by providing inservice training for all teachers on various methods that incorporate writing into subjects. Compositions show greater fluency and audience awareness in classrooms where teachers promote many forms of discourse that lead to writing in all subjects.

Other considerations for implementing a campuswide writing program include:

- Cooperatively developing a statement of philosophy that expresses the beliefs of all teachers about writing and how it should be taught in their school
- Involving all teachers in coordinating a writing program that is developmentally appropriate for students and sequential across grades

Administrative Support

Developing a writing program requires long-term commitment by administrators. Most successful programs are managed by both teachers and administrators. One strong indication of program commitment is for administrators to actively participate in staff development activities. This participation allows administrators to sharpen their own teaching skills, as well as evaluate the inservice presentations. In this way, administrators are able to effectively monitor the writing program, keeping attuned to its progress. Administrators should serve as program advocates, supporting staff members who contribute to its development and maintenance.

The program can be coordinated by an English language arts specialist, the department chairperson, a central office administrator, or the campus principal. This person must be knowledgeable enough about the writing process to keep the program on target and make adjustments when needed. The coordinator should also have taught elementary students.

Other considerations for defining the role of administrators include:

- Ensuring ample time for paperwork corrections
- Allowing release time or making other arrangements to facilitate inservice participation
- Assisting teachers in explaining the writing program to parents

Classroom Instruction

Drills on isolated skills are the thrust of instruction in many elementary classrooms. Opportunities for students to write complete compositions are often avoided because of excessive concern with mechanical correctness. This approach stifles student interest and significantly delays the development of their writing ability.

Research proves that students learn to write by writing; therefore, classroom

activities form the foundation of any writing program. Students must be allowed ample opportunity to perform significant writing tasks, with emphasis placed on the total writing process of prewriting, writing, and revising that leads to a final product. The program design should encourage teachers to model writing behavior in the classroom. This modeling helps students understand that practice in writing is an ongoing process, even for adults.

Effective writing programs involve high levels of interaction between students and teachers who facilitate writing activities paralleling the interests students have outside of school. Writing lessons should provide an active role for students and flow naturally out of other activities.

Other considerations for developing guidelines for classroom instruction include:

- Providing opportunities for students to write frequently
- Beginning writing instruction in kindergarten with brainstorming activities and lessons that build strong vocabularies
- Delaying or providing "as needed" instruction in grammar until students feel comfortable expressing themselves in written form
- Giving students opportunities to write for varied audiences and in many modes, including those appropriate for subject matter
- Evaluating student writing in a nonthreatening manner; that is, with emphasis on revision rather than on correction

Once A Program Has Been Implemented

A writing program has the potential to offer many rewards to any district that invests the time and effort to ensure its success. The increased quality of instruction will ultimately lead to improved student test scores. Once the program is in place, administrators and teachers must be dedicated to maintaining consistency and high standards.

Considerations for maintaining an existing writing program include:

- Rewarding teachers for their efforts to maintain and improve the writing program
- Providing opportunities for elementary and middle school teachers to discuss the sequential development of writing instruction
- Demonstrating the writing process to parents and explaining campus policy for teaching grammar, grading papers, and measuring progress
- Providing regularly scheduled meetings for teachers to discuss the status of the program
- Regularly monitoring classroom instruction
- Providing teachers with current professional materials

High-caliber writing programs vary from district-to-district and campus-to-campus. All writing programs however, *should* express campus and district individuality, because all successful writing programs have one common element: They embrace the unique needs of each and every teacher and student.

Reference List

Brannon, L. and Knight, M. 1982. *Writers Writing*. Boynton/Cook Publishers, Inc., Upper Montclair, New Jersey.

Grant, B. and Hennings, D. 1981. *Written Expression in the Language Arts*. Teachers College, Columbia University New York, New York.

Holbrook, H. 1986. *Qualities of Effective Writing Programs* ERIC Clearinghouse on Reading and Communication Skills, ERIC Digest. Urbana: Illinois.

Neil, S. 1982. *Teaching Writing: Problems and Solutions*, American Association of School Administrators, Educational News Service, Sacramento, California.

Proett, J. and Gill, K. 1986. *The Writing Process in Action*, National Council of Teachers of English, Urbana: Illinois.

In successful writing programs, writing is not viewed as a separate subject, but rather as a part of all subjects.

REVISION IN THE WRITING PROCESS

Written by
Lanny van Allen,
English
Language Arts
Specialist

Teachers are usually successful at motivating students to put ideas on paper and into a rough draft, but it is at this point that the most difficult teaching of writing actually begins. The goal is to have students write a composition, stand back and look at it objectively and then, as readers, complete the final revision. This cannot be accomplished in a short time, but by the second semester a teacher can have most if not all students in the class "trained" to revise their own work successfully most of the time.

We know that all phases of the writing process are important and, that because the process is recursive rather than linear, the writer will perform many operations more than once. Donald Murray says writing is a social event—between a writer and a reader—and a student intensely involved in getting ideas communicated on paper is unable to switch quickly to the reader role.

One teacher calls it her "layaway" plan, putting compositions aside for a few days or even a couple of weeks, so that when they are brought out again, the students usually say, "Did I write this?" At this point, students become readers in the social event and can review their work more objectively. Here, they usually make major revisions. The process is recursive; although surface revisions or changes are made in the first, second, and other drafts, students will still need direct instruction and extensive writing experience over a long period of time—perhaps even as professional adults—to develop the skills, confidence, and maturity to perform deep revision "surgery" to their papers.

In junior high school, teachers hope to take students from a "let's check the spelling and copy it over in ink before handing it in" idea of revision to a more involved, responsible attitude that comes with writing often to develop fluency. Kirby and Liner remind us that students are interested in revising only if the thing to be revised is meaningful and important to them; if they have become involved in the making of a piece worth repairing. In the process of composing, people use both hemispheres of the brain—the left hemisphere processing information; the right side contributing to the creative process with emotions, intuition, and other powers. While the cerebral hemispheres are in gear, so to speak, teachers want to provide opportunities and challenges that cause students to use many types and levels of thinking. Sandra Stotsky's extensive research prompted her to write:

> For anything to be truly learned or comprehended, it must be worked through completely. Writing may be the most active way of ensuring that process. Further, to be understandable, it demands more thought and attention than speech. By requiring students to respond in writing to words and ideas that they are asked to recall, reproduce, restate, select from, generalize, reorganize, integrate, or elaborate on, we may be providing them with the most active comprehension practice possible. . . . Thus, exercises that give students structured, active practice in grappling literally with the language and ideas of these forms of discourse may be particularly useful. . . .

And so within the writing process, teachers provide active practice in grappling and thinking. A composition assignment using the writing process could possibly proceed from operations like recall and comprehension in the prewriting phase, to application and analysis in the drafting stage, to synthesis and evaluation in the postwriting or revision stage. Teachers provide active practice, not by leaving students alone to write, or by saying, "In this activity we're going to analyze," but by providing literature, discussions, films, or games that will capture their interest and get

For anything to be truly learned or comprehended, it must be worked through completely. Writing may be the most active way of ensuring that process.

Sandra Stotsky
The Role of Writing in Developmental Reading,
Journal of Reading,
January 1983

them involved. When teachers have carefully planned and executed rewriting activities, seldom do students moan, "I don't have anything to write."

It's helpful when planning to be aware of the developmental patterns of students. Piaget tells us that junior high students fall at the end of the concrete operational stage of development and at the beginning of the formal operational stage. In the concrete operational stage, children, more independent in their thinking, can think logically, classify, and show relationships. Their thinking revolves around immediate and concrete objects rather than concepts and abstractions. Teachers who know and understand these students recognize that, almost overnight, many of them move into formal operations and are able to apply logical operations to all classes of problems. They are able to reason about abstract objects and concepts that they haven't directly experienced. Although this is a simplified summary of the theory of cognitive development, Bushman shows us it can be helpful to teachers structuring writing programs in the intermediate school.

Writing Revision Conferences

If teachers consider the developmental level of these adolescent students and want to teach them the beginning steps of revision, as well as develop their thinking skills, one of the most useful resources is the writing conference.

Teacher and Class

The first type of conference is one between the teacher and the entire class. Using the overhead projector, the teacher reviews a carefully selected student composition, re-written in the teacher's handwriting, with a preplanned set of questions:

- What is the purpose of this piece? (comprehension)
- How did you determine this? (analysis)
- Who is the audience? (analysis—making inferences)
- What does the writer do to communicate his purpose and his audience (analysis—means and mode)

Another discussion might include this line of questioning:

- What is the writer saying in this line? (comprehension)
- Do you think the writer intended to say this? (evaluation)
- Given this purpose and audience, how could the writer communicate his idea more successfully? (synthesis)
- Is there a piece missing as one moves from one idea to another, or is there any item that should be omitted? (evaluation)

Conferences with the class as a whole should be carefully planned with a particular focus and follow-up activity. The conferences should address only composition problems and needs that the teacher feels are widespread in this particular class. (During this type of conference, students may keep a log of ideas that are discussed and note the examples given.)

Teacher and One Student

The second type of conference is between the teacher and one student, while the remainder of students in the class work on specific activities. Here the teacher calls student folders into play. (Each student has a composition folder filed in the classroom. Parents have been informed at the beginning of the year that they can review the contents in parent-teacher conferences at school, when the teacher can explain objectives for this process.)

As the folder contains drafts of all writing the student has done this year,

the teacher can ask the student to select favorite and least favorite pieces of writing. The teacher asks (1) why the student made these choices (analysis), (2) which specific aspects of the pieces the student likes or dislikes (application), and (3) content questions such as, "Can you tell me more about the way this car looked? What can you add that will help me get a better picture of it? What would happen if you put this paragraph first? What idea is this sentence tied to?"

The teacher may address technical aspects of the paper that constantly interfere with communication; for example, "You have two ideas in this sentence. Read to me, stopping after the first idea." If the student's problem is short, choppy sentences, then hearing the paper read aloud may help. The individual attention a teacher gives a student in this type of conference can help the student feel his words are important and that he is of value in many other ways.

Through the process of these conferences, the teacher models how authors should look at a composition and the approach they should take in making changes in it. Students do not come to class knowing how to look at their own compositions as readers and, consequently, they are not skillful at scrutinizing either their own or their peers' writing.

Teacher and Two or Three Students

The third type of conference involves the teacher and two or three students. Again, the teacher models the approach or procedure for scrutinizing the composition in order to improve it and training the students to work with their peers. The teacher suggests questions they can ask each other, such as, "Do you think this composition would be better if Max added more details? Do you agree with the conclusions that he made?" or "What do you predict about audience reaction to this section? If you were writing about this topic, how would you approach it?" The time and effort spent on this kind of training showing junior high students how to "think through" the composition will reap benefits for them as writers in high school and beyond.

Student Working Independently

The folder is also used in the fourth type of conference: the student as an independent learner. After training students to look objectively at their work, it follows that they should be given an opportunity to make a few independent decisions. Donald Murray suggests that students may not like everything they write, may honestly feel that no revision is necessary, or may feel that more time is needed to develop an idea, composition, or both. Perhaps these options could be offered to the writer:

- complete the present project and publish it as scheduled
- complete another composition in the folder that the student thinks is better, or
- choose not to turn in a piece at this time (maybe a once-in-a-six-week-period opportunity)

In all revision activities, teachers should expect all students to be actively involved in writing and to learn to revise their work routinely, just as they routinely learn mathematical operations. Note, too, that the questions students have been asked in conferences have been about ideas, not mechanics. By dwelling on mechanics constantly, we give them the impression that mechanics are more important than ideas and the thought process itself. Mina Shaughnessy, in Hull and Bartholomae, illustrates how debilitating a concern for correctness can be to a writer. Philip Anderson says it well:

If the piece of writing is meaningful to them, most students are willing to revise extensively.

Dan Kirby and Tom Liner
Inside Out, 1981

A . . . note about the development of written language skills and understanding is that students' sophistication grows through attending to meaning first, and form second. In other words, students will use the relative clause first, and learn how to punctuate it later. Insistence by the teacher that students punctuate everything correctly under all circumstances will end up discouraging student use of more sophisticated constructions. The time to teach the proper punctuation of many grammatical constructions is after the construction is securely in the students' writing. The implication here, of course, is more attention to individual development as evidenced in students' writing, and less attention to whole-class grammar and mechanics lessons. Working with students on an individual basis need not be an overwhelming task, if one remembers that students usually can attend to only one or two writing problems at a time anyway. The teacher is not solving everyone's problems all at once, and not working with each student's total development as a writer, but attending to problems when needed and allowing the students to develop as writers through writing.

Practicing the technique of sentence combining is a worthwhile writing activity. Recent research shows that such practice does transfer: students tend to write more mature or complex sentences on their own and show gains in general quality of their compositions. If students begin sentence—combining work in the elementary grades, then continue with more sophisticated activities in junior high, they will show greater progress in high school. William Strong, who has done extensive research in this area, says in Stotsky that the mental activities in sentence combining are what make it such a powerful approach, and that if "...sentence combining works because it trains a kid to hold longer and longer discourse in his head—to embed and subordinate at greater depth as a means of expressing thought . . . it is a means to intervene in cognitive development and, perhaps, to enhance it."

Sentence-combining exercises can be used successfully in the conferences discussed earlier with the class as a whole, using the board or overhead projector; or with one or two students, addressing their particular problem area. Marian Mohr tells students, "I am not suggesting that you attempt longer and longer sentences in your writing, but that you give yourself lots of practice in manipulating the sections of a sentence and its punctuation."

In working with eighth graders, Sharon Austin notes that her students were not transferring their practice with sentence-combining exercises to their compositions, so she made combining a part of each student's revision process. Near the end of the year one student said, "I like to write when I can begin with easy thoughts and then go back and combine to make my paper sound good." Austin was pleased that many of the students had improved the flow and variety of sentences and were also beginning to understand the process of writing.

In summary, the use of conferences, writing folders, and sentence-combining exercises has been suggested to promote progress during revision. As revision is taught it's necessary to consider the writing process, the developmental stages of the students, and the composing experience of the writers. Students and teachers have to work together: composing is sometimes lonely and usually involves a struggle. As Donald Graves says, "Revision, or reseeing, is not necessarily a natural act. It draws on a different source of energy, the energy of anticipation. The carpenter planes, sands, varnishes and sands again, all in antici-

. . . the mental activities in sentence combining are what make it such a powerful approach. . . .

William Strong in Stotsky

pation of running the hand over the smooth surface, the pleasure to the eye of gently curving lines, the approval of friends. The carpenter has been there before, knows what will be coming, and trusts his ability to solve the problems along the way." Our junior high students will not become "graduate" carpenters before going to high school, but they can begin to realize the products their energy can produce.

Reference List:

Anderson, P. Winter 1983. Practical Applications of Language Learning Theory in the Middle School and Junior High. *Research in the Teaching of the English Language Arts*, IX, 18-22.

Austin, S. June 1986. "Beyond Sentence Combining." *The Quarterly of the National Writing Project and the Center for the Study of Writing*, 8, 5-7.

Bushman, J. Spring 1985. "A Writing Sequence for the Junior High/Middle and Secondary School English Curriculum." *Virginia English Bulletin*, 35, 3-9.

Glatthorn, A. *1980 A Guide for Developing an English Curriculum for the Eighties*. Urbana: National Council Teachers of English.

Graves, D. 1983. *Writing: Teachers and Children at Work*. Exeter NH: Heinemann.

Hazelkorn, J. Fall 1982. Writing on the Lay-away Plan in the Junior High. *Illinois English Bulletin*, 70, 42-43.

Hennings, D. 1986. *Communication in Action—Teaching the Language Arts*. Dallas: Houghton Mifflin Company.

Hull, G. & Bartholomae, D. April 1986. "Teaching Writing as Learning and Process." *Educational Leadership*, 43, 44-53.

Kelly, P. & Small, R. Spring 1985. "Two Stacks Later: Composition." *Virginia English Bulletin*, 35, 1-3.

Kirby, D. & Liner, T. 1981. *Inside Out*. Montclair: Boynton/Cook Publishers, Inc.

Mohr, M. 1984. *Revision—The Rhythm of Meaning*. Montclair: Boynton/Cook Publishers, Inc.

Murray, D. 1986. Presentation on writing at NCTE, San Antonio.

NAEP. November 1986. *The Writing Report Card*.

Romanish, B. Fall 1986. "Critical Thinking and the Curriculum: A Critique." *The Educational Forum*, 51, 45-56.

Stotsky, S. January 1982. "The Role of Writing in Developmental Reading." *Journal of Reading*, 25:4, 330-340.

Strong, W. 1986. *Creative Approaches to Sentence Combining*. ERIC: NCTE.

Thompson, E. H. Spring 1985. "Making Writing Conferences Work." *Virginia English Bulletin*, 35, 42-47.

THINKING SKILLS IN JOURNALISM AND SPEECH COMMUNICATION

Written by
Lawrence Richard,
English Language Arts Specialist

Communication skills, both oral and written, have traditionally been part of the secondary school curriculum. Ernest Boyer's *High School* states that language is the first curriculum priority and that it is incumbent upon high schools to "help all students develop the capacity to think critically and communicate effectively through the written and spoken word." For this reason the graduation requirements of Chapter 75 include four credits in English language arts, the essential elements of which feature writing and language concepts and skills. Not only are written and oral language effective means of expressing thought, they are also excellent ways of developing thought; hence, as students become more proficient in the skills of expressive language, they also sharpen their critical thinking skills. Two areas of the English language arts curriculum focus especially on developing the critical thinking skills of self-expression: journalism and speech communication.

Journalism

The mandate of Chapter 75 to include teaching the writing process in required language arts courses was designed to effect a major improvement in the English curriculum of Texas public schools. To achieve competent writing skills, students need instruction in the process of writing, as well as frequent opportunities to practice purposeful writing. As they go through the stages of the writing process—from prewriting to drafting to revising to publishing—students discover facts and information, determine their relevance to the communication they are working on, and present them in writing using rhetorical techniques appropriate to the purpose and audience of the communication. The exploration of ideas, which is a necessary part of the writing process, requires students to engage repeatedly

Not only are written and oral language effective means of expressing thought, they are also excellent ways of developing thought; hence, as students become more proficient in the skills of expressive language, they also sharpen their critical thinking skills.

Reference List:

Boyer, E. 1983. *High School, A Report on Secondary Education in America*, The Carnegie Foundation for the Advancement of Teaching, New York, Harper & Row.

Dvorak, J. 1985. "Journalism's Role in the Secondary School Language Arts Curriculum in the Context of the Educational Reform Movement," a paper presented at the midwinter meeting of the Secondary Education Division of the Association for Education in Journalism, Indianapolis, Indiana.

Kirby, D. and Liner, T. 1981. *Inside Out*, Montclair, New Jersey, Boynton/Cook Publishers, Inc.

in various forms of critical thinking such as pattern recognition, synthesis, analogical reasoning, and evaluation of evidence. "Writing is thinking on paper" is not just an idle slogan; it is an essential characteristic of a worthwhile English program.

A program of academic journalism centers around the writing process. And although the production of a newspaper, literary magazine, or yearbook is a part of the journalism program, the program's main purpose is far wider. It involves the development of students' critical thinking skills as they assume the media's obligation to report what readers want and need, without skirting unpleasant or complex issues that challenge them intellectually, morally, and ethically. Students investigate and write about real topics that vitally interest them and their audience, and the publications they produce serve as the forum for their thinking.

English teachers frequently have trouble motivating students to write. In order for the students to take the trouble to go through the whole writing process, the pieces of writing on which they are working must be important to them. Tom Liner says, "The usual situation in the classroom is that students want to finish papers as quickly as possible and turn them in so they won't have to fool with them anymore." One way to supply motivation is to provide students with publishing opportunities, "...the only reason for the writing to be important enough for the hard work of editing and proofreading." Because journalism students have a regular publishing outlet, and the tasks they deal with concern real issues and relevant topics, the motivation problem is very much lessened. Dvorak says, "...teaching writing skills in a journalism class is easier than in an English class 'because students have a sense of immediate audience, an extremely important factor in communication.'"

Critical Thinking in the Journalistic Writing Process

The writing process in the context of news is an important essential element for Journalism. One of the first tasks students must accomplish is to "understand the elements of news." Many teachers, frequently with the aid of textbooks, present a list of the characteristics of newsworthiness students must discuss and analyze. Other teachers, using a more Socratic approach, elicit a list of news elements from the students themselves. Once the list is determined, an examination of a variety of sample news stories helps students see how the elements of news are actually found in journalistic writing.

Another key essential element in Journalism is to "gather information through interviews." Here, of course, is one of the central prewriting activities in the journalistic writing process. Students first sharpen their interviewing skills by observing and criticizing recorded interviews, practice them in role-playing simulations, and finally conduct actual interviews, looking throughout the process for verifiable facts, reliable testimony, and relevant details. Discussions with professional reporters about interviewing techniques can also broaden students' grasp of this important skill.

Once students have gathered news, writing and editing news stories continue the journalistic composing process. Five essential subelements address this:

- differentiate among and write straight, interpretive, and feature stories, including effective leads
- use inverted pyramid form
- use journalistic style

- edit copy using appropriate copyreading and proofreading symbols
- write effective headlines and cutlines

Although journalistic writing has specific skills to be mastered, such as using the inverted pyramid form and producing headlines and cutlines, engaging in the drafting and editing stages of the writing process is no different from what any writer does. Purpose and audience are identified and addressed, and rhetorical techniques are used that will most effectively accomplish the purpose for a particular audience. Specific conditions like time and space constraints challenge the journalism students, but purpose and audience will guide the content and tone of the writing. The writing process here as anywhere is usually a recursive one, requiring the writer to produce a draft, then to go back and revise, perhaps several times. Critical thinking skills are important throughout the process as students investigate the reliability of their sources, eliminate bias, develop accuracy in their statements, and check for logical fallacies in their reasoning. Interaction with peers and guidance by the journalism teacher can help students develop the kinds of skills that enable them to grasp a particular topic or problem and present it in an appealing and thoughtful way to their audiences.

Few areas of the curriculum engage students as fully as journalism in the purposeful production of the written word, and journalism teachers are in a unique position to provide their students with the critical thinking skills involved in the process. As students engage in such activities as recognizing and gathering news, writing and editing news stories, and collecting, condensing, and organizing materials from various sources of information, they in higher order thinking skills. And since the news draws its content from an unlimited range of topics, students' cross-disciplinary abilities are exercised and strengthened as they deal with a wide spectrum of subject matter. It is no accident that freshman college students with high school journalism experience earn significantly higher test scores than their counterparts with no publications background. We can be confident that a strong, academic journalism program will help build thinking and writing skills that will serve students throughout life.

Speech Communication

Ernest Boyer in *High School* stresses the need for "a study of the spoken word" in the high school curriculum. He suggests that every student should take a one-semester speech course that includes group discussion, formal debate, public speaking, and oral interpretation of literature, and points out that the goal of such a course is not only effective self-expression, but reflective thinking. Although the descriptions of required English courses treat oral language in only one subelement, the elective speech communication courses deal with all four areas that Boyer recommends.

Group Communication

The study of the dynamics of group communication affords ample ground for the exercise of critical thinking skills. For groups to function at their fullest potential, students must analyze types of groups, their purpose, and patterns of interaction. A frequent purpose of group discussion is problem solving, a step-by-step process involving analysis, synthesis, and evaluation.

Debate

Formal debate has long been recognized as a discipline in which students exercise critical thinking skills; effective debate has for centuries been the trademark of educated and responsible citizens. Analyzing debate topics and preparing arguments for persuasive presentation help students build the thinking and verbal agility that assure effective oral presentations.

Public Speaking

Public speaking especially demands the skills of analysis and synthesis. The general task of organizing ideas for a speech is similar to organizing ideas for a piece of writing: purpose and audience are primary guidelines. But there are also different skills to master. In an oral presentation, for example, students learn to present a message in a way that listeners can readily follow, interpret, and understand as they listen, since they cannot go back over the text and verify or probe an idea. Students, therefore, must master skills of organization specifically for an oral presentation, repeatedly operating on the cognitive levels of analysis, synthesis, and evaluation.

Oral Interpretation

Finally, the area of oral interpretation requires students to analyze a literary selection from several points of view. This analysis entails an examination of meaning, attitude, structure, and style; then the selection is synthesized into the particular adaptation that will suit the purpose, audience, and occasion the speaker must address.

The critical thinking skills exercised in these four areas of oral communication are usually not arrived at without careful instruction and painstaking practice. Speech communication, far from centering around the surface features of oral delivery, deals with the most profound aspect of language and communication: thought. Just as in journalism, students must be encouraged to deal with topics that are vitally meaningful to them and challenge them intellectually, morally, and ethically.

LIBRARY MEDIA

REALISTIC
EDUCATIONAL
ACHIEVEMENT
CAN
HAPPEN

THINKING EXPERIENCES *ARE* LIBRARY EXPERIENCES

Written by
June Kahler,
Library Services Specialist

School library media specialists play an integral part in the major role of every school: teaching students to think. They play their part by providing activities that encourage creative projects and critical thought, holding discussions with students to focus on their informational needs, and conducting demonstrations of logical thinking. But with the new importance placed on developing thinking abilities, this is an especially opportune time to highlight opportunities available in the library media center for extending thinking skills. When teachers and specialists base instruction on student needs, true integration of research skills, critical thinking skills, and classroom content occurs.

The Library Media Center Program

What to Teach

The library media program consists of two equal strands—library skills and literature enrichment. The major focus of most library media programs during the early years of schooling centers around reading, viewing, and listening experiences. Many forms of presentation and literature are included. This early focus on literature provides a natural introduction and smooth transition to information skills that particularly encourage the development of thinking. Yet, if considered at face value, common library skills may appear to be at the lowest level of Bloom's Taxonomy. Some of these skills are:

- Understand the arrangement of information within the library media center; for example, the arrangement of books by the Dewey Decimal System or the alphabetical arrangement of a dictionary

- Use basic information resources like reference books and the card catalog

29

John Dewey expressed the belief that 'all which the school can or need do for pupils, so far as their minds are concerned, is to develop the ability to think.' To develop this ability, students should be consciously taught to 'think about their thinking,' a process referred to as metacognition.

- Select resources from a variety of formats
- Use comprehension skills to gain meaning from whatever is read
- Retrieve information from these sources using note-taking skills and outlining
- Communicate information to others in reports, audiovisual projects, and oral presentations
- Develop literary appreciation skills to provide personal enjoyment and scholastic growth

Without these skills, however, even the most talented students will have difficulty producing higher quality products. The best library media center program combines thinking processes with literature enrichment and library information skills. A creative library media center staff served with excellent resources adds to the program quality.

When to Teach

For students to learn a skill meaningfully, timing is critical. First, students must be developmentally ready to learn the skill. Otherwise, premature attempts to teach library skills will only lead to frustration, confusion, and potentially negative feelings toward the library media center. Second, the skill should be valued by students because it solves their immediate problem.

How to Teach

John Dewey expressed the belief that "all which the school can or need do for pupils, so far as their minds are concerned, is to develop the ability to think." To develop this ability, students should be consciously taught to "think about their thinking," a process referred to as metacognition. Linda Bertland notes that the research indicates library media specialists should model metacognitive behavior. Telling students what to do is not nearly as effective as demonstrating or "talking through" the thinking process when working with groups or with students individually. Bertland says that to model metacognitive behavior, specialists should:

- **Think out loud about the process in which they engage, in terms of planning their approach to a problem, monitoring their comprehension, developing strategies, and performing self-evaluation.** When a student asks the library media specialist for a book about tigers, the specialist should restate the problem aloud, talk about refining or focusing the request, then talk and walk through the process of using the card catalog, finding the proper shelf location, and selecting the best book for this student. It is important that the student hear thinking taking place.
- **Engage students in activities that force them to think about their own thinking.** The specialist can help students identify what they already know about the problem, then help them outline the tasks and strategies essential to solve the problem.
- **Allow students to teach each other by working in small groups.** Each group may work on a topic of interest such as studying carefully chosen books. As literature sets of the same title are read by a group with similar reading abilities, the specialist, teacher, or a student can follow up with in-depth discussion. Group members relate their own experiences and concerns to the situations and characters of the book, then consider the author's solutions before proposing their own solutions to the story's problem.
- **Provide opportunities for training in strategies that will help students monitor their own comprehension, planning, and thinking activities.** Selecting a library book for free reading allows students to ask themselves such questions as, "Is this something I can read? Is it too hard or too easy? Is this a topic I

30

am interested in? Is it about a topic we are studying in class? Will I read this book for entertainment or to help me with an assignment? Have I read other books by this author? Did I like them?'' When students answer these questions, they are comparing and contrasting, categorizing, ranking order, predicting, inferring, and justifying. Students should be made aware that they are going through this process.

- **Help students develop the ability to ask the right questions.** Asking the correct question is paramount to finding workable solutions. This activity may be done through brainstorming in group situations or by encouraging students to write down every question related to the topic, then prioritizing and eliminating extraneous questions. For example, when assigned a broad topic such as "Write a report on some facet of the Great Depression,'' students would define the Great Depression, write down every topic possibility, then narrow the topic to an area of personal interest such as their great-grandparents' experiences, as told by their grandparents.

It is equally important that library media specialists and teachers ask the right questions. In literature enrichment activities, carefully planned pre-story and post-story questions will engage students in creative and critical thinking. Research has found a close relationship between the levels of comprehension students display in their responses and the types of questions asked by teachers. Sixth graders who were consistently asked high-level questions scored significantly higher in social studies achievement than those who were consistently asked low-level questions.

- **Provide actual hands-on experience.** The library media center serves as a laboratory for hands-on experience not available in the classroom. By using the card catalog drawer, or the *Reader's Guide to Periodical Literature*, for example, students apply and demonstrate their learning.

- **Work with teachers on precise explanations of the exact nature of assignments so that students are aware of the task parameters involved and the possible difficulties they may encounter along the way.** Explaining to students at the beginning of a lesson not only what they will be doing, why they will be doing it, and the problems they may encounter, demonstrates respect for them as persons deserving to be informed. It also communicates the expectation of students as thinkers capable of critical and creative decision making and problem solving.

Resources, Staff, and Training

The components of a library media program that should be adequately developed and functioning to provide a strong thinking-skills curriculum are:

- Resource collections to implement the skills curriculum
- Technology to utilize resources
- Staff to develop and administer the program, teach skills, and maintain facilities
- Local production capacity to provide synthesis through student-made audiovisual materials
- Flexible scheduling that allows students free access to the library media center as needed
- Staff development in collection development, questioning techniques, and technical skills

Library media specialists know what is being taught, when, and by whom, across grades and subjects, making it possible to connect meaningfully

Telling students what to do is not nearly as effective as demonstrating or 'talking through' the thinking process when working with groups or with students individually.

31

with both teachers and students. Because they are aware of the total curriculum of the school, they need not respond to or wait for a teacher-initiated project but can take the initiative themselves. Or, library media specialists can make teachers' tasks become much more manageable by pooling their efforts to infuse thinking skills into the curriculum.

As a result, students should know how to evaluate the ideas and facts they hear, read, or retrieve, and how to apply what they know to a new problem. We must give our students the means to become lifelong, independent learners—the techniques in addition to the tools; the process, not only the product.

Reference List:

Berkowitz, B. & Berkowitz, J. May 1987. "Thinking is critical: moving students beyond location." *School Library Media Activities Monthly*, 3:9 25-26.

Bertland, L. Winter 1986. "An overview of research in metacognition: implications for information skills instruction." *School Library Media Quarterly*, 14:2 96-99.

Hughes, C. Fall 1986. "Teaching strategies for developing student thinking." *School Library Media Quarterly*, 15:1 33-35.

Jay, M. Fall 1986. "The elementary school library media teacher's role in educating students to think." *School Library Media Quarterly*, 15:1 28-33.

Laughlin, M. & Watt, L. 1986. *Developing Learning Skills Through Children's Literature: An Idea Book for K-5 Classrooms and Libraries*. Phoenix: Oryx Press.

Leonard, P. 1985. *Choose, Use, Enjoy, Share: Library Media Skills for the Gifted Child*. Littleton, Co: Libraries Unlimited.

Mancall, J. & others. Fall 1986. "Educating students to think: the role of the school library media program." *School Library Media Quarterly*, 15:1 18-27.

Markuson, C. Fall 1986. "Making it happen: taking charge of the information curriculum." *School Library Media Quarterly*, 15:1 37-40.

Polette, N. & Hamlin, M. 1980. *Exploring Books with Gifted Children*. Littleton, Co.: Libraries Unlimited.

Polette, N. 1984. *The Research Book for Gifted Programs*. O'Fallon, MO: Book Lures, Inc.

THINKING SKILLS AND HIGH SCHOOL LIBRARIES

Written by
Mary Boyvey,
Director of
Library
Media
Programs

Librarians and teachers cooperatively plan high school research units. One of their major considerations is to ensure that all students progress through the various thought levels of research—the critical thinking skills—from simple fact-finding to the complex level of conceptualizing. From the primary grades through junior high school, the foundation for mastering research skills has been laid. Now, at various stages of the research process, students must have time to engage in the thought level of reaction; that is, to progress through the critical and creative thinking skills of simple recalling to complex synthesizing.

In the research process, students accomplish the following steps.

Step 1

Select a Broad Topic

The topics should interest students and allow for thoughtful research. Controversial topics should be avoided to allow students to be objective and unhindered by preconceived beliefs or biases. Adult assistance may be needed to help them distinguish between researchable and nonresearchable topics.

Step 2

Obtain an Overview of the Topic

Students should be able to develop an overview, discuss it, and identify the best sources for their topic. They should also be able to use an encyclopedia correctly and take paraphrased notes on an article's main and minor points.

Step 3

Narrow the Topic

Students must be able to identify the principal issues in the broad topic. This can be done in outline form or by using webbing to identify minor components. Distinguishing the general from the specific, and the broad from the narrow, helps them focus on interesting aspects of the topic. By narrowing the topic selection, they can relate the assigned length of the project more easily to the chosen subject.

Consideration Point:

Is the topic feasible?

After the first three steps are completed, students should have time to review their work and decide whether to continue or retrace their steps to make alterations. This is a time when they might profit from class discussion or individual consultation with a teacher or librarian. Both students and teachers or librarians must be satisfied that the narrowed topic is suitable for the project.

Step 4

Choose Format of Final Project

Students must select a presentation format appropriate for the topic. What medium best communicates the research results? Regardless of the medium, how can the information be presented most effectively?

Consideration Point:

Is the format appropriate? Students may require adult assistance to choose an appropriate format.

Step 5

Develop A Thesis Statement Or Statement of Purpose

Students should be able to define a thesis statement or statement of purpose and identify the statement in other essays. The development of this statement will help beginning researchers clarify the major focus of the topic.

Consideration point:

Does the statement of purpose represent an effective, overall concept for the research project?

33

Now, at various stages of the research process, students must have time to engage in the thought level of reaction; that is, to progress through the critical and creative thinking skills of simple recalling to complex synthesizing.

Step 6

Formulate Questions To Guide Research

Writing questions ranging from factual to interpretive and evaluative will help students recognize the types of information needed to cover the topic.

Consideration point:

Do the questions provide a foundation for the research?

Step 7

Find, Analyze, and Evaluate Sources

In this step, students learn to use a variety of subject headings, sources, and indexes. Knowledge of the Dewey organization aids browsing in the library. By this time, students can recognize and select appropriate types of reference books and determine if each source provides answers to the research question. By analyzing sources, students evaluate their reliability.

Consideration Point:

Are the sources usable and adequate?

Step 8

Evaluate Evidence, Take Notes, Compile Bibliography

Students are now ready to identify essential information within each source and recognize which information answers which question. They distinguish between important and unimportant, relevant and irrelevant, and decide which type of notes to take for each piece of evidence. They understand what plagiarism is and how to avoid it. They use note cards efficiently and interpret evidence.

Consideration Point:

Is the research complete?

Step 9

Establish Conclusions, Organize Information Into An Outline

Students are now in a position to generalize from specific facts, draw warranted conclusions, or recognize valid conclusions from others. This is the time for students to re-evaluate questions, perceive relationships that exist among major aspects of the topic, and develop an outline for the final product.

Consideration Point:

Are the conclusions based on researched evidence? Does the outline logically organize conclusions and evidence?

Step 10

Write Paper, Prepare Presentation

Students now begin composing their papers or presentations by choosing data and organizing the ideas according to the outline. After the first draft is prepared, revising and editing begin. A peer group can assist with revising by judging the appropriateness, order, and meaning of data for purposes of accuracy, clarity, and thoroughness. The work should be edited by checking it against a self-evaluation form.

Consideration Point:

Is the paper or project satisfactory?

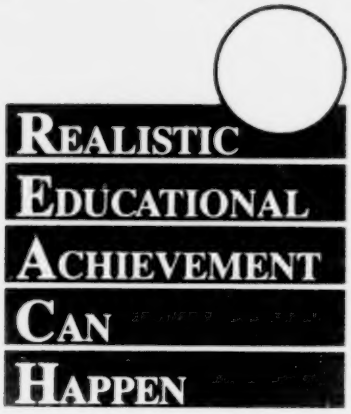
Reference List:

Frevert, A. nd. *Developing Research Independence: A Student Handbook*. Houston, Clear Lake High School. (Unpublished Manuscript)

Stripling, B. & Pitts, J. Fall 1988. *Teaching Interactive Library Research, or Please Don't Check Your Brains at the Desk* (tentative title) to be published by Libraries Unlimited, Inc.

34

MATHEMATICS



35

PUTTING COMPUTATION IN ITS PLACE: TECHNOLOGY AS A BRIDGE TO THINKING

Written by
Cathy Seeley Peavler,
Director of
Mathematics

Too often in our current instructional program, experiences in problem solving are reserved for students who have mastered computation, and then only as an extension or application of computation skills. Mathematical problem-solving experiences can in fact be made available to all students, regardless of their proficiency in computation, and can often provide a vehicle to reinforce or even teach computational skills that may be lacking. By limiting experiences with sophisticated, interesting problems to students who have demonstrated proficiency in computation, educators may be overlooking an opportunity to identify and develop excellent mathematicians—problem solvers—under the mistaken belief that mathematical ability and computational facility are synonymous.

The role of computation

Computation is an important component of the mathematics curriculum. It is not, however, all of mathematics, nor, in fact, the most important aspect of mathematics. An examination of essential elements shows that computation is part of only one essential element for any given grade or course. The curriculum is rich with the rest of mathematics: number concepts, the meaning of operations, problem-solving strategies, geometry, measurement, graphing, probability, statistics, applications, and much more.

Of all the skills and concepts addressed in the mathematics program, the most likely to be replaced by a readily available tool—the calculator—is computation. Yet many teachers continue to believe that their primary responsibility is to teach students how to compute. Spending the majority of instructional time on computation in any mathematics course at any grade simply cannot be justified. The cost is too high for

The purpose behind the recommendation that technology be integrated into the mathematics curriculum is not to dazzle students with nifty gadgets, but to allow students to focus on problem solving and on analysis of mathematical concepts.

students if they miss the opportunity to learn mathematical concepts and to apply higher order thinking skills to mathematical problem situations. The cost is too high to society if we cannot prepare a broad base of confident problem solvers and informed citizens to approach complex future problems.

In our technological society, computation still remains important in the mathematics curriculum, but with a few notable changes in emphasis. At the primary grades, the new emphasis must be on understanding the meaning of the operations. The National Council of Teachers of Mathematics in *Curriculum and Evaluation Standards for School Mathematics*, separates computation from operations as two separate strands in the elementary curriculum. Students must build on concrete experiences with manipulative materials to develop a solid understanding of addition, subtraction, multiplication, and division. With this solid understanding, students proceed to learning (memorizing) basic facts, especially in addition and multiplication, leading eventually to computation algorithms. The process of memorizing basic facts must be efficient, non-threatening, and meaningful. This precludes the use of page after page of isolated drill and practice sheets or timed tests that do not allow students to complete a set of facts and place students in a situation where their progress is compared to others. It also precludes the token use of technology as simply a replacement for the same type of drill and practice. While computerized drill and practice is one approach to practicing facts, it should not be the only approach. It may be preferable to have students work on one family of facts at a time, perhaps addition with subtraction or multiplication with division, with parents helping at home on flash cards for that fact family. Students can improve their speed at reciting facts individually, rather than by working in groups. In no case should student proficiency on facts, especially based on timed tests, be used to place students into long-term instructional groups.

As students progress from recalling facts to the study of computational algorithms (procedures), teaching must continue to focus on conceptual understanding. Multiplication and division algorithms can be taught meaningfully through developmentally sequenced activities using base ten materials or other concrete models. This type of teaching, while it may appear to be time-consuming, can in fact shorten the length of time it takes students to reach mastery at an abstract level.

An additional focus of teaching computation at all grades must be on a student's ability to estimate answers to computation problems and to judge reasonableness of answers to problem situations. Students must be able to judge when it is most appropriate to estimate or compute exactly, when it is most appropriate to compute mentally, or with pencil and paper, or on a calculator, and what operations are appropriate for any given problem situation. This means that students must develop an in-depth understanding of what mathematics is and can do for them, and how mathematics can help students approach real-life problems.

This view of computation emphasizes students developing a foundation for applying higher order thinking skills later, including the ability to analyze mathematical problems, synthesize previously learned content, apply mathematical concepts, and evaluate problems and their solutions. This groundwork clearly prepares students

to use mathematics, and to think mathematically—not simply to do mathematical procedures.

The Shifting Spiral

Various reports, especially *The Underachieving Curriculum*, have recommended a re-examination of the spiral curriculum as it now exists in most mathematics programs. The great amount of content "covered" in each level of mathematics appears to be repeated year after year, not only in grades K-8, but also from Algebra I to Geometry to Algebra II to Precalculus. This approach does not seem to be accomplishing its intention of building a foundation and extending beyond that foundation year after year. Rather, it seems to be leading to watered-down exposure at the expense of in-depth instruction for mastery. Flanders has reported in a study of mathematics textbooks, ranging from kindergarten through algebra courses, that much of what is covered each year has been covered previously. In fact, he has observed that the average amount of new material presented in three major textbook series for grade 8, for example, represents only 30 percent of the course. Much of the repetition is found in extensive review of computation. The implications of these studies are clear: we must shift the emphasis of mathematics instruction to put computation in a reasonable role, we must expect mastery of content at specific grades, and we must get on with teaching students to understand the substance of mathematics.

Technology facilitates this shift in two ways: by allowing students to learn concepts in mathematics never before studied in certain grades or courses, and by allowing teachers to spend less time teaching computation and more in-depth time teaching other areas of mathematics in depth. Content and activities such as those described by Lappan and others and the American Statistical Association offer relevant, interesting topics that could be taught if extra time were available in the curriculum.

The role of technology in the mathematics classroom

Technology gives educators an opportunity to move students past the barrier of computational facility to content and experiences that represent the substance of mathematics—solving conceptual mathematical problems, NCTM's *Agenda for Action* recommends that the instructional program in mathematics "must take full advantage of the power of calculators and computers at all grade levels." The word "power" is important here because by using computers and especially calculators, students can solve sophisticated and interesting problems. Technology gives teachers the opportunity to use yet another method to empower students with mathematics—to help students realize they have a wealth of tools available to represent and solve a variety of problems. The purpose behind the recommendation that technology be integrated into the mathematics curriculum is not to dazzle students with nifty gadgets, but to allow students to focus on problem solving and on analysis of mathematical concepts. NCTM's publication on standards reflects a heavy emphasis throughout the curriculum on using calculators and computers as a means for students to experience higher levels of mathematical thought.

Calculators help teach problem-solving strategies. Mark Driscoll, in a synthesis of research on calculator use in classrooms, indicates that—in addition to being useful in diagnosing understanding and in enhancing effective teaching behaviors—

. . . educators may be overlooking an opportunity to identify and develop excellent mathematicians—problem solvers—under the mistaken belief that mathematical ability and computational facility are synonymous.

calculators can also support teaching mathematics concepts, including problem-solving strategies like estimation, retracing one's steps, discovering patterns, making an organized list, and judging the reasonableness of answers. Students are also more likely to be willing to attack a problem, even one with "messy" numbers, if they have access to a calculator for computing. Since perseverence is an important component of the ability to solve problems (Ohio Department of Education, n.d.), this notion can be exploited to encourage students to continue to work on a problem, even where it might involve several attempts with different approaches.

Calculators also help teach the mathematical concepts that underlie the ability to solve problems. Elementary students can develop one meaning for multiplication—repeated addition—by experimenting with repeated addition on the calculator. Students quickly can explore exponents in depth without having to do lengthy computations by hand. Driscoll observes that the concept of ratio taught in middle school can be developed without the typical distraction of lengthy computations, which often interfere with a student's exploration of ratio in problem situations. In high school, students can analyze the concept of geometric and algebraic representations for the same function with a computer or graphing calculator in ways never before possible in a classroom.

With the use of calculators and computers, certain areas of mathematics can be included in the instructional program that could not otherwise be addressed. For example, students compute compound interest or work with amortization schedules, they can make conversions between metric and customary units where needed in real problems, and they can analyze classes of graphs of higher-order functions under various parameter changes. Computer simulations can provide an opportunity to explore probability concepts that have traditionally been viewed as beyond the scope of most mathematics classrooms.

Summary

Mathematics educators must carefully determine how calculators, computers, and future technologies can be used to improve mathematics curriculum and instruction. And they must also examine the relevance of computation to the total mathematics program. Without question, instruction in the 1990s will continue to focus on teaching students higher order thinking skills to solve problems—a focus greatly enhanced by the suitable use of calculators and computers at every grade.

Reference List:

American Statistical Association—National Council of Teachers of Mathematics 1986. *Quantitative Literacy Series.*

Driscoll, M. 1983. "The calculator: An essential teaching aid," in Research Within Reach: Secondary School Mathematics, Reston, VA: NCTM of Teachers of Mathematics.

Flanders, J. September 1987. "How much of the content in mathematics textbooks is new?," *Arithmetic Teacher,* 18-23.

Lappan, G. & others. 1986. Middle grades mathematics project, Menlo Park CA: Addison-Wesley.

McKnight, C. & others. 1987. The underachieving curriculum: assessing U.S. school mathematics from an international perspective, Champaign IL: Stipes Publishing Company

National Council of Teachers of Mathematics. 1980. An Agenda for Action, Reston, VA.

National Council of Teachers of Mathematics. September 1987. Curriculum and evaluation standards for school mathematics, working draft, Reston, VA.

Ohio Department of Education, in conjunction with the United States Department of Education. nd. Problem solving...A Basic Mathematics Goal #2: A Resource for Problem Solving, Columbus, OH.

Texas State Board of Education, 1986. *Long Range Plan.* Texas Education Agency, Austin, TX.

PROBLEM SOLVING THROUGH GRAPHING

Written by
Ramona Jo DeValcourt,
Mathematics Specialist

Graphing is a motivational way to begin each class and increase student interest in mathematics. Graphing activities also teach a number of significant skills, including those related to higher order thinking, as follow:

- counting
- comparing
- adding
- subtracting
- finding fractional parts
- finding percentages
- gathering data
- classifying data
- organizing data
- reporting data
- drawing conclusions
- evaluating conclusions
- solving word problems
- relating mathematics to students and other subject areas

Topics and questions for graphing activities should be directly related to the interests and experiences of the students. According to Betty Coombs and Lalie Harcourt, "Emphasis should be placed on graphing as a problem-solving tool; that is, a way to clearly display and then interpret information." Students can use graphs to make decisions about unknown situations based on known information. Mathematics specialist Marilyn Burns also states: "Graphing is a way to present statistics in a concise, visual way that makes it possible to see relationships in the information more easily." These relationships allow students to make projections about possible solutions to problems. By using graphs of real data to solve mathematics problems, children deal with numbers in ways that make mathematics meaningful in the real world. "Too many children can do arithmetic," she says, "but cannot use it to solve problems. It's essential that arithmetic be taught in the context of its applications."

How Can Graphing Be Taught?

Elementary school teachers can make graphs out of many materials in different ways. Children can record their responses with chalk on graphs drawn on the chalkboard or with magic markers or stickers on graphs drawn on butcher paper. Permanent graphs can be made on poster board and laminated. Some should be left untitled so they can be reused. Spray the graph with a product like Spray Mount and the squares will stick to the board when students place them in the correct row or column. They will remain stuck to the board until removed and the graph can be used again.

For younger children, graphing mats can be made from large sheets of plastic for use on the floor. Use real objects for recording. To record in an organized manner, have students come to the graph in small non-academic groups. Teacher comments might be: "If you have blue eyes...if you have brown hair...if you're wearing a necklace...if you like chocolate ice cream...if you watch Saturday morning cartoons...come to the graph and record your response."

All graphs should have a title, and the columns or rows should be labeled with an appropriate picture or word. Bar graphs must have equal spacing for each bar. Venn diagrams, graphs that use circles to represent logical relations, can be made of two or three interlocking circles. These may be more difficult for some students to interpret.

Graphing should be taught sequentially, moving from concrete to abstract. Three types of graphs—real, picture, and symbolic—can be used in each of the following three categories:

Graphs that ask for opinions, graphs that require reporting of facts, and graphs that require finding unknown information before recording the in-

By using graphs of real data to solve mathematics problems, children deal with numbers in ways that make mathematics meaningful in the real world. Too many children can **DO** *arithmetic but cannot* **USE** *it to solve problems. It's essential that arithmetic be taught in the context of its applications.*

Marilyn Burns
The Math Solution—
Leadership Training,
1984

formation needed. Burns described the types of graphs as follows:

- **Real graphs** compare actual objects and build on children's understanding of more and less. Dealing with concrete objects helps children develop the concept of graphing. An example is: "Are you wearing shoes with laces or shoes without laces?" Students make a graph by lining up shoes with or without laces in separate rows.
- **Picture graphs** use pictures or models to stand for real things. Children can draw a picture to represent the actual object or cut pictures out of magazines. A cut-out of their shoe, a picture of the cookie they chose, or a picture of their pet are some examples. The question could be, "What is your favorite pet?" Students place the picture of the animal in the correct column of the graph.
- **Symbolic graphs** are the most abstract because they represent real things. A colored square, a tally mark, or cut-out circle could all represent real objects.

Burns points out that it is important to discuss and interpret graphs with the class. Graphs are the source of numerous questions that can be answered by analyzing the data provided, she says. Thus, they provide a ready supply of word problems that relate to student experiences and give them an opportunity to apply mathematics skills. Coombs and Harcourt state, "Encourage the children to ask questions for which the answers may be discovered and displayed on the graph. Knowing the right question to ask is also an important problem-solving skill."

Students can graph any question they select—all they need is a title, a label for each column or row, and student responses to their question recorded in the appropriate row. Schedule time on different days to have the students present their graphs. Have them state what they were interested in finding out and the result of the graph. Then students can ask the class questions about the graph. To keep students' attention focused on the meaning of the information obtained from the graphing exercise, it is important to discuss and interpret each of them. These graphs can be posted as a bulletin board display.

Sample Graphs

Mathematics teacher Marji Freeman developed the following questions to construct graphs that build higher order thinking skills:

Teacher Notes For:

"Are You the Oldest, Youngest or In-between Child?"

Basic Skills Questions

- How many students filled in this graph?
- Give the decimal that represents the number of students who are the oldest child.
- What percent of students are the youngest child?

Analytical or Extension Questions

- Brainstorm reasons it might be easier to be the oldest child or youngest child.
- List the advantages or disadvantages of being the youngest, in-between, or oldest child.
- What are some other questions we could ask about this graph?

Personal or Opinion Questions

- If you had a choice, would you rather be the youngest, oldest, or in-between child? Explain your answer.
- Do parents treat the oldest child different from the youngest?

Other Activities

- Have students find out if their parents are oldest, youngest, or in-between children. Graph the information. An "only" child should be counted as an oldest child.

Are you the oldest, youngest, or an in-between child?

Make an X.

Oldest	**Youngest**	**In-between**

Teacher Notes For:

"In Which Month Were You Born?"

Basic Skills Questions

- In what month were most people born?
- What percent of people were born in the summer? (June, July, August)
- What fraction of people were born in March?

Analytical or Extension Questions

- If you could choose a different month for your birthday, what month would you choose? Why?
- What do you think is the worst month to have a birthday? Why?
- What traditions does your family observe during birthdays?

Other Activities

- Research how birthdays are celebrated in other countries. Compare their traditions.

In which month were you born? **Color a box.**

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.

Encourage the children to ask questions for which the answers may be discovered and displayed on the graph. Knowing the right question to ask is also an important problem-solving skill.

Betty Coombs and Lalie Harcourt
Explorations 1, 1986

Emphasis should be placed on graphing as a problem-solving tool; that is, a way to clearly display and then interpret information.

Betty Coombs and Lalie Harcourt

Teacher Notes For:

"Which Type of Fast Food Do You Like Best?"

Basic Skills Questions

- How many more students liked hamburgers better than hotdogs?
- What percent of the students considered pizza their favorite food?
- What fraction liked fried chicken?

Analytical or Extension Questions

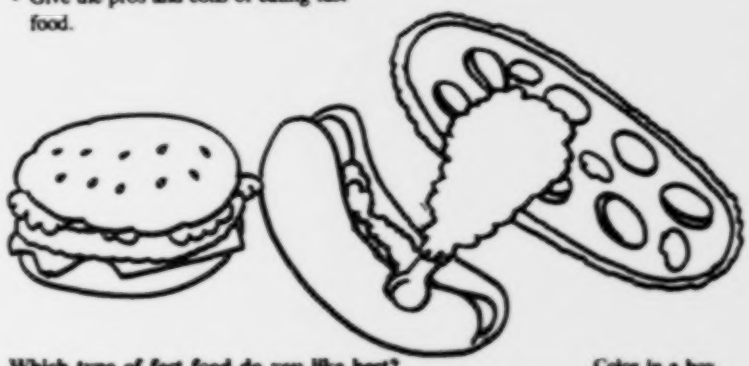
- What is meant by the term "fast food?"
- How many fast food places are there in your neighborhood?
- Give the pros and cons of eating fast food.

Personal or Opinion Questions

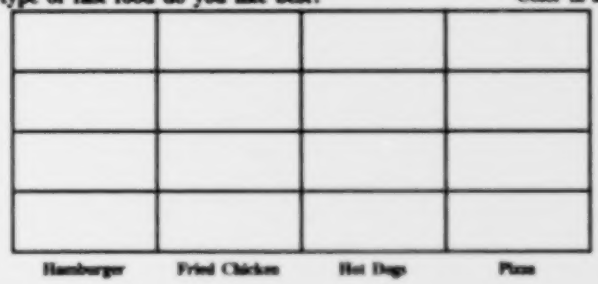
- Should only fast food be served for lunch in the school cafeteria?
- Is fast food healthy? Explain.
- What is the main reason people eat fast food?

Other Activities

- Create a graph to find out how many times a week each student eats fast food.
- Poll students to find out why they eat fast food.
- Find out the calorie count and nutritional value of several fast foods. Compare them to other foods.



Which type of fast food do you like best? **Color in a box.**



Teacher Notes For:

"What Is Your Favorite Ice Cream?"

Basic Skills Questions

- How many students chose strawberry as their favorite ice cream?
- What percent liked vanilla ice cream?
- Create another graph that shows this information.

Analytical or Extension Questions

- What are some different ways to eat ice cream?
- How many different flavors of ice cream do you think there are? Name them.
- Create another graph that shows this information.

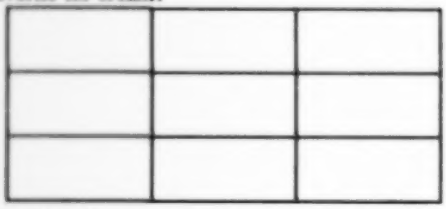
Personal or Opinion Questions

- What do you like or dislike about this graph? How would you change it?
- What is your favorite dessert other than ice cream?

Other Activities

- Research the calorie count and nutritional value of ice cream.

What is your favorite ice cream? Color a box.



Teacher Notes For:

"How Do You Come To School?"

Basic Skills Questions

- What percent of students come to school by car?
- What is the most common way of coming to school?
- How many more students ride a bike than walk to school?

Analytical or Extension Questions

- What factors determine how students come to school?
- Do you think the data on this graph would be different for elementary (high school, college) students?
- Who would need the kind of information on this graph?

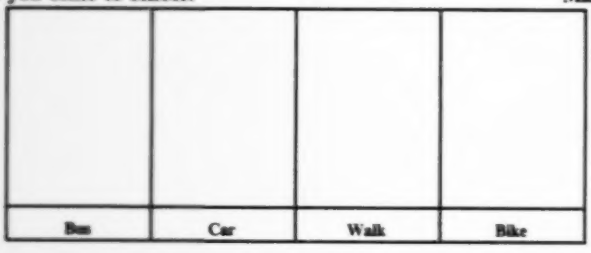
Personal or Opinion Questions

- How will the ways you come to school change as you get older?
- Should schools be close enough so that everyone can walk or ride their bike to school?
- What is your favorite way to come to school?

Other Activities

- Have students create a method for determining how the entire school population comes to school. (They could observe students or use a questionnaire, for example.)

How do you come to school? Make an X.



Graphing is a way to present statistics in a concise, visual way that makes it possible to see relationships in the information more easily.

Marilyn Burns

Coombs and Harcourt suggest the following key questions for discussing various graphs:

- What does this graph tell us?
- Which column has more (less, most, least)?
- Are any columns the same? What does that mean?
- Are there more (less)_____ than_____? How many_____?
- How many more (less)_____ than_____?

Other questions that can be asked are:

- How many_____are there altogether?
- Do at least half the students prefer _____ to _____?
- What fraction (or percentage) of the class preferred_____?
- What questions do the graphs not answer?
- How many more would you need to add to the column that contains fewer responses to make it equal to the column with the most responses? This is an example of finding the missing addend.

What color are your eyes? Make a tally mark.

Blue	
Green	
Brown	
Hazel	
Black	
Other	

The Spinner Graph **Follow the directions.**

1. Spin the spinner.
2. Write the number that comes up in the correct row.

1									
2									
3									

Is your last name longer, shorter, or the same length as your first name? Color a square.

Longer												
Shorter												
Same Length												

How many claps in your name?

- RA-MO-NA has 3 claps.
- Write your first name in the correct place.

1	2	3	4
		Ramona	

Reference List:

Coombs, B. & Harcourt, L. 1986. Explorations 1. Canada: The Bryant Press Limited.

Burns, M. 1984. *The Math Solution—Leadership Training.* California: Marilyn Burns Education Associates.

Freeman, M. 1983. *Creative Graphing* San Antonio, Texas: Staff Development Publications.

USING GEOMETRY TO TEACH PROBLEM SOLVING IN JUNIOR HIGH

Written by
Barbara Montalto,
Mathematics Specialist

In the decade of the 1980's, problem solving has been the number one priority of the National Council of Teachers of Mathematics. Junior high school mathematics in Texas should reflect this focus on problem solving, while at the same time connecting the concrete, conceptual mathematics of elementary school to the abstract, application of high school courses.

Geometry provides both a way to teach problem solving and a way to teach for problem solving. To teach problem solving is to develop problem-solving strategies that can be used to solve a variety of problems, much like tools a carpenter selects for a particular task. To teach for problem solving is to teach mathematics in such a way that learning is meaningful and useful in solving future problems. It is important for students to see the teacher pose a problem, discuss different strategies to solve it, model the solution, and then pose a new problem that builds on the one just solved.

No one is more acutely aware of the need to help junior high school students successfully bridge the gap between concrete and abstract thinking than are teachers of these students. It is common for these teachers to encounter students who, for example, (1) recognize a square but cannot define it, or (2) don't recognize that a square is also a rectangle. However, by using the van Heile model of geometric thought to recognize these indicators of geometric maturity, they can effectively assess student abilities and guide instruction.

The model identifies five levels of understanding—visualization, analysis, informal deduction, formal deduction, and rigor to describe characteristics of the thinking process. The materials and methodology

Junior high school students should acquire the cognitive maturity to recognize alternative solutions to a problem, know how to develop them, and then progress to deductive solutions. But the problems must be high quality problems that are relevant, interesting, and varied.

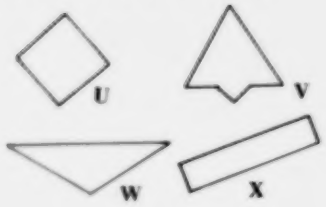
designed to match the levels of understanding allow students to progress from one level to the next.

Level 1—
Visualization

Students functioning at this level are aware of space, recognize parts or properties, can learn geometric vocabulary, reproduce a figure, and sort shapes such as triangles, squares, circles, and rectangles by simple attributes.

Sample activity:

Which of these are rectangles?



(A) None of these are rectangles.
(B) U only
(C) V only
(D) U and X only
(E) V and X only

Level 2—
Analysis

Students functioning at this level begin to observe properties of figures and make generalizations about classes or groups of figures.

Sample activitiy:

Complete the sentences:
The opposite sides of a rectangle are _____ and _____.

A square is a rectangle with _____.

Level 3—
Informal Deduction

Students at this level can conceptualize the interrelationships between properties of a single figure and classes of figures. They also understand and develop definitions, follow and give informal arguments, and follow the logic of, but cannot construct, a formal proof.

Sample activities:

(a) Define a rectangle in two different ways.

(b) Identify and draw a figure given an oral or written description of its properties.

Level 4—
Deduction

Students are able to see the interrelationships and role of undefined terms, axioms, postulates, definitions, theorems, and proofs. A student at this level can construct proofs, recognize more than one way to prove a theorem, and understand necessary and sufficient conditions.

Sample activity:

Prove the relationships developed informally at Level 3.

Level 5—
Rigor

Students can work in a variety of axiomatic systems and abstract non-Euclidian geometries. This level of understanding is usually appropriate for university courses.

Since 1981, research studies have supported the accuracy of the van Heile model for assessing geometric understanding. (Geddes and Fuys, Burger and Shaughnessy, and others) The same research also shows that the materials and methodology, which are designed to match the levels of understanding, promote growth to the next level. Junior high school teachers should use materials and methodology to help students progress through Levels 1, 2, and 3.

While students are learning geometric concepts, they can also be engaged in problem-solving activities. Some important problem-solving strategies appropriate for teaching geometry are to: make an organized list, vary the conditions of the problem, look for patterns, and list all of the possibilities. An example of a series of questions and activities that progress from Level 1 through 3 follows:

[1] Using a set of pattern blocks:

- What is the maximum number of blocks you can use to fill in the design?

Can you fill it:

- with only two blocks?
- with exactly three blocks?
- with exactly four blocks?
- What is the maximum number of identical blocks you can use to fill in the design?
- How many different ways can you fill the designs with blocks?
- How many of these use all identical blocks?
- If you use the smallest pattern block for an area unit of one, what is the area of the figure?
- Is the area the same for all coverings?
- Can you form different figures with the same area?

[2] Using a geoboard, complete the following tasks and record your answers on dot paper that is congruent to the geoboard:

- Make a figure with an area of 6 square units.
- How many different figures can you make with the same area?
- How many different rectangles can you make with an area of 6 square units?
- For an area of any whole number, can you make a rectangle with one side of length 2? If so, why? If not, why not?
- When is it not possible to make a rectangle with one side of length 2? What kind of numbers are these?
- Can you tell by looking at a number if it will be possible to make a rectangle with that area, which also has one side of length 2? How?
- Can you generalize this for any given area?
- What if the side needed to be length 3?

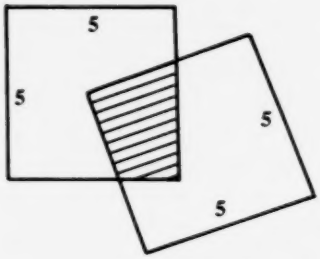
An extension of these activities could be a visual representation of prime numbers (only one way to construct a rectangle), composite numbers (more than one way to construct a rectangle), and square numbers (an odd number of non-square rectangles and one square).

Junior high school students should acquire the cognitive maturity to recognize alternative solutions to a problem, know how to develop them, and then progress to deductive solutions. But the problems must be high quality problems that are relevant, interesting, and varied. The 1987 Yearbook of the National Council of Teachers of Mathematics contains

Geometry activities can develop and improve student spatial abilities, which are accurate predictors of success in high school mathematics.

such problems in a chapter by George Milauskas entitled "Creative Geometry Problems Can Lead to Creative Problem Solvers." Here is a good problem for investigating alternative solutions:

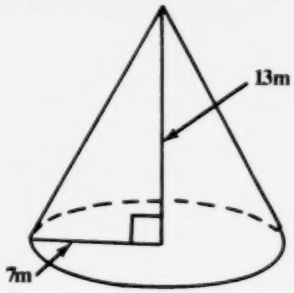
Example:
Two congruent 5 cm x 5 cm squares overlap as shown. A vertex of one is at the center of the other square. What is the largest possible area for the overlapping area? (The top square is movable as long as the vertex remains in the center.)



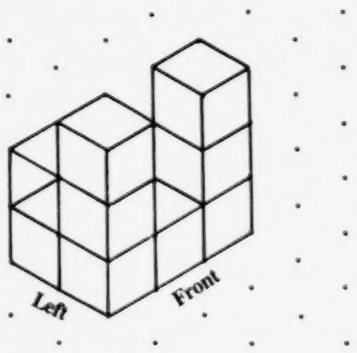
Spatial Perception and Geometry
Geometry activities can develop and improve student spatial abilities, which are accurate predictors of success in high school mathematics. These seven spatial abilities appear to have the greatest relevance to academic development: eye coordination, figure perception, perceptual constancy, position in space perception, perception of spatial relationship, visual discrimination, and visual memory.

Students need visual pictures to develop their ability to transfer what they know to unfamiliar situations that require higher level thinking. They gain most of their mathematical experience with three-dimensional objects by working with two-dimensional pictures of the object. While it is difficult for many students to visualize an object from a picture, learning to "see" an object from its two-dimensional representation is an important skill. Visualizing the whole object is a critical step in developing an understanding of volume, for example, which is a concept found on most standarized tests.

Example:
What is the volume of this model?



The best way to demonstrate the spatial concept of three dimensions is to build, draw, and evaluate. As students build models from cubes or blocks and observe them from different perspectives, they develop their spatial skills. Students should draw pictures of the model from different perspectives on dot paper, then discuss and compare their drawings with each other and evaluate them for accuracy.



Summary
Geometry activities can be used to teach problem-solving strategies, to teach for problem solving, and to develop spatial visualization skills. These skills are three important links in the bridge that connects concrete and abstract thinking. Instruction in these areas will ensure students who can think mathematically and apply higher order skills to solve real problems.

Reference List:

Burger, W. & Shaughnessy, J. January 1986. *Characterizing the van Hiele Levels of Development of Geometry*, Journal for Research in Mathematics Education.

Geddes, D., Fuys, D. & others. 1985. *An Investigation of the van Hiele Model of Thinking in Geometry Among Adolescents*, Research in Science Education Program of the National Science Foundation, Grant No. SED 7920640, Washington, D.C. NSF 1985.

Jones, B., Palincsar, A. & others. 1987. *Strategic Teaching and Learning: Cognitive Structure in the Content Areas*, Association for Supervision and Curriculum Development, Alexandria, Virginia.

Lappen, G., Fitzgerald, W. & others. 1986. The Middle Grades Mathematics Project: *Mouse and Elephant: Measuring Growth*, *Factors and Multiples*, *Similarity and Equivalent Fractions*, *Probability*, and *Spatial Visualization*, Menlo Park, California, Addison-Wesley Publishing Company.

Lindquist, M. & Shulte, A. eds. 1987. *Learning and Teaching Geometry*, K-12, 1987 Yearbook, National Council of Teachers of Mathematics, Reston, Virginia.

THINKING IN MATHEMATICS AND THE TEAMS EXIT TEST

Written by
Bill Hopkins,
Mathematics Specialist

The Texas Educational Assessment of Minimum Skills, mandated by House Bill 72 in 1984, is designed to be an indicator of student achievement on selected minimum skills. To graduate from high school, students must pass the TEAMS Exit Test. Because the publication of local test scores has placed schools under careful scrutiny from the public, as well as the Texas Education Agency, schools feel pressured to implement an academic program that will not simply improve TEAMS scores; it must also graduate their students.

The heavy emphasis on improving TEAMS scores can have a positive effect on mathematics curriculum and instruction; however, if the focus of instruction becomes too narrow, the opposite effect may occur. To achieve positive, long-range improvement, districts must be careful to avoid certain pitfalls that could increase TEAMS scores, but be detrimental to the long-range ability of students to learn and use mathematics. The purpose of this article is to show how the high school mathematics program can prepare students to be successful problem solvers and—at the same time—improve TEAMS Exit scores.

Teaching students to think for themselves should be the ultimate goal in mathematical problem solving. Thus, a crucial question mathematics educators must resolve is: How can problem solving be taught most effectively? Lester states that most problem-solving instruction does not enable students to think and often does more harm than good. He says there is a real danger that the type of mathematics instruction we provide students is training them to be rigid in their thinking, not flexible and adaptable; is teaching them how to perform procedures, but not when or under what conditions; and is showing them what to do but not why.

Teaching students to think for themselves should be the ultimate goal in mathematical problem solving. Thus, a crucial question mathematics educators must resolve is: How can problem solving be taught most effectively?

On the TEAMS Exit test, three of the 18 mathematics objectives require students to compute; seven require students to recall information or compute to solve a problem, or both; and eight require students to perform higher level thought to solve a problem.

The computation objectives are:

- Solve problems involving addition, subtraction, or multiplication of fractions and mixed numbers
- Use the basic operations to solve decimal problems
- Solve problems involving addition of integers

These objectives are thoroughly addressed in the elementary and junior high school curriculum. If some high school students need remediation, it should be done individually and not as a part of the high school program. If large amounts of time are spent on these objectives, students simply will not have the time necessary for learning higher level high school material.

The lower level problem-solving objectives are:

- Select the set of numbers that is correctly ordered from least to greatest
- Round numbers to a particular place value
- Identify equivalent fractions, decimals, and percents
- Convert numbers from exponential notation to standard notation
- Use geometric properties to solve problems involving geometric shapes
- Solve word problems involving averages
- Solve problems to determine the value of a variable

These objectives require students to recall information, apply appropriate computation, or both. Again, students deficient in these areas should be given individual remediation while studying higher level skills taught in the high school program.

The TEAMS Exit Test objectives that require higher level thinking are:

- Solve word problems involving multiple operations of whole numbers, decimals, fractions, and mixed numbers
- Solve word problems involving proportions
- Solve word problems involving percent
- Solve problems involving metric or customary measurements using basic operations
- Solve problems involving geometric formulas
- Solve word problems involving simple probability
- Use information from graphs and tables to solve word problems
- Solve word problems using formulas

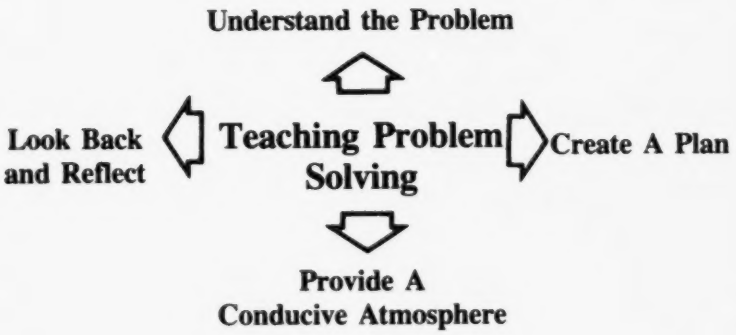
Practice on higher level objectives often requires the use of lower level skills, enabling students to maintain their ability in these skills. Thus, as higher level skills improve, so do others. By focusing the bulk of instructional time on higher level thinking objectives, school districts can benefit their students doubly.

Since teaching higher level thinking is difficult and requires extensive planning and cooperation, school districts should work with teachers to develop a foundation for teaching these thinking processes. Cooney, Davis, and Henderson, in their text titled, *Dynamics of Teaching Secondary School Mathematics*, present maxims that, if practiced by students, should help them become more effective problem solvers. When teaching

students to solve problems, teachers should serve as models by also using these maxims:

- Make sure students understand the problem
- Help students gather relevant ideas to assist in creating a plan
- Provide an atmosphere conducive for students to solve problems
- Encourage students to look back and reflect on the problem and the means used to solve the problem

This model can be illustrated as follows:



As teachers use this model of instruction, they might consider questions related to each maxim published in the Georgia Department of Education's *Mathematics for Georgia Secondary Schools*:

Make sure students understand the problem.

- Do students understand the meaning of terms used in the problem? Are there ambiguous terms that need clarifying or illustrating?
- Do the students identify all . >- vant given conditions and information?
- Do the students determine what they are being asked to find? Would a solution to the problem take the form of a number, a set of numbers, an equation, a graph, a pattern or other mathematical object? How can such a solution be generated?
- Can students restate the problem in their own words? Would a sketch be helpful in explaining the problem?

Help students gather relevant ideas to assist in creating a plan.

- What information can be derived from the given conditions? What relations or implication can be deduced from the given conditions or from the assumed type of solution? Should more brainstorming take place? What subset of generated information is most likely to be relevant? Are students being encouraged to generate novel plans for attacking the problem? Can more than one plan be devised? Has there been an attempt to form a plan by deriving information from joint consideration of the given and the sought-after solution to the problem? Are slower students being brought into the planning stage? Is the teacher telling too much? Would a different or more elaborate sketch be helpful?

Practice on higher level objectives often requires the use of lower level skills, enabling students to maintain their ability in these skills. Thus, as higher level skills improve, so do others. By focusing the bulk of instructional time on higher level thinking objectives, school districts can benefit their students doubly.

- Can students gain information by solving an analogous problem? Is it possible to try smaller values of some variable in order to see a pattern or reasonable solution?
- Do students attempt a different approach if they become blocked or discouraged? Does their mind set need breaking? What would be a different perspective for considering a particular problem? Is an approach being abandoned too soon?

Provide an atmosphere conducive for students to solve problems.

- Are the students receiving positive cues from the teacher? Are they being encouraged to continue their approaches? Are teachers squelching approaches too much?
- Are students being given sufficient time to deal with a problem? Should more time be provided for ideas to incubate?
- Are students being taught to make intelligent guessing? Is the teacher encouraging and rewarding students who make conjectures and helping them to test their conjectures? Are teachers modeling a problem-solving process by making conjectures and experiencing false starts of their own?
- Are students being made aware that there are usually many ways to solve a problem? Are they being encouraged to seek alternate solutions? Is there adequate discussion of the processes involved to find the solution?

Encourage students to look back and reflect on the problem and the means used to solve the problem.

- Does the solution make sense? What other means could be used to verify the solution?
- Does the conclusion obtained really solve the problem? Should the problem be reformulated and the problem-solving cycle be repeated?
- What insights about the original problem and related problems are provided by the solution?
- What are other ways to solve the problem? What occurs if you focus on some other feature of the problem? Does that suggest a different approach?
- If the problem was solved inductively, can a deductive solution be determined and vice versa?
- What subproblems were suggested and dealt with in obtaining the solution?
- What new problems can now be generated? What if some aspect of the problem were changed?
- How can the problem and solution be applied? What occupations might encounter such a problem?
- What would be different if a calculator or computer were available?
- Have there been sufficient classroom discussions about the critical role of employing maxims in dealing with problems?
- What questions or remarks from students could be exploited by the teacher to help students seek solutions or formulate new problems?
- Were the students having fun in their problem-solving activity?
- Are students aware that the maxims used in the mathematics classroom apply to almost any challenging life situation they may encounter?

How mathematics scores are improved on the TEAMS Exit Test must be a priority for our schools. A curriculum that includes large amounts of instruction focused on higher level thinking will provide not just short-term, but maximum long-term benefits to our students. Coordinating problem-solving maxims with the high school mathematics curriculum will provide a basis for teaching these higher level processes. In such an environment, how can TEAMS scores or students lose?

Reference List:

Cooney, T., Davis, E. & others 1975. *Dynamics of Teaching Secondary School Mathematics*, Houghton Mifflin Company, Boston.

Costa, A. April 1984. "Thinking: How Do We Know Students Are Getting Better At It?," *Roeper Review*, 197-199.

Georgia Department of Education. 1981. *Mathematics for Georgia Secondary Schools.*

Grouws, D. 1985. "The Teacher and Classroom Instruction: Neglected Themes in Problem-Solving Research," *Teaching and Learning Mathematical Problem Solving: Multiple Research Perspectives*, Lawrence Erlbaum Associates, Publishers, 295-308.

Halmos, P. August-September 1980. "The Heart of Mathematics," *American Mathematical Monthly*, 519-524.

Kilpatrick, J. 1985. "A Retrospective Account of the Past 25 Years of Research on Teaching Mathematical Problem Solving," *Teaching and Learning Mathematical Problem Solving: Multiple Research Perspectives, Lawrence Erlbaum Associates*, Publishers, 1-15.

Lester, F. 1985. "Methodological Considerations in Research on Mathematical Problem-Solving Instruction," *Teaching and Learning Mathematical Problem Solving: Multiple Research Perspectives*, Lawrence Erlbaum Associates, Publishers, 41-69.

Marzano, R. and Arredondo, D. 1986. *Tactics for Thinking Teacher's Manual*, Association for Supervision and Curriculum Development, Mid-continent Regional Educational Laboratory.

McGinty, R. and Meyerson, L. October 1980. "Problem Solving: Look Beyond the Right Answer," *Mathematics Teacher*, 501-503.

Tobin, K. and Capie, W. November 1980. "Teaching Process Skills in the Middle School," *School Science and Mathematics*, 590-600.

Yeotis, C. and Hosticka, A. November 1980. "Promoting the Transition to Formal Thought Through the Development of Problem Solving Skills in Middle School Mathematics and Science Curriculum," *School Science and Mathematics*, 557-565.

DEVELOPING THINKING IN THE FUNDAMENTALS OF MATHEMATICS CLASS

Written by Barbara Montalto, Mathematics Specialist

The Fundamentals of Mathematics course is designed to re-teach students who are two or more years below grade level in mathematics and failed or scored low on the 7th grade TEAMS test. Analysis of the TEAMS data indicates that students who pass or fail TEAMS do almost equally well on lower level computation objectives. The difference in performance appears to be on higher level objectives like equivalencies; word problems using ratio, proportion, and percent; geometry; and probabilities. Thus, it appears that FOM teachers can best help students by focusing the course not on re-teaching elementary computation skills but on developing thinking skills.

How can teachers best accomplish this? By adjusting the three curricular variables: content, process, and product.

The content variables are concepts and ideas included in the course, the process variables are ways in which teachers present course content, and the product variables are student performance levels and expectations teachers have of the students.

Content

As illustrated on the next page, the essential elements of the FOM course already provide a framework in which to solve problems requiring higher level thinking skills.

. . . scores on all course objectives will improve if teachers replace dull, repetitive, drill-and-practice instruction with motivating activities that are fun and thought-provoking.

Essential Elements	Problem-solving approach
EE1(B) solve problems involving measures	• word problems and problem-solving activities involving units of measure
How many pieces of sod 2 feet by 3 feet would be needed to cover a lot 135 feet by 90 feet, if the house and driveway cover 300 square feet?	
EE2(B) apply geometric properties	• geometric properties applied to a variety of situations and non-routine problems.
A company that manufactures containers receives an order for a round container 10 centimeters in diameter with a capacity of 1 liter. Allowing for 1 centimeter of space above the liquid, how tall must they make the container?	
EE3(E) use the operations of +, -, x, ÷ in problem situations	• problem-solving applications that reinforce computational skills and provide for extensions
EE4(C) apply percents	• cost comparisons for consumer purchase and sales, excise, and hidden taxes
Two different stores have the same shirt for sale. The shirt sells for $15. One store is offering a 20 percent discount and the other $2 off any item in the store. Which is the better buy?	
Extensions: Which would be a better buy on an $8 item? What would be the cost of an item for which savings would be the same at both stores?"	
EE5(A) estimate solutions	• estimation of an answer before solving and reasonableness of an answer after solving a problem • a wide variety of problem-solving strategies • methods to solve simple equations
EE5(C) measure	• problem-solving activities using units of measure
EE5(F) use graphs	• problem-solving activities using charts, graphs, and tables • calculator and computer activities to solve problems
EE6(E) make predictions	• predictions using charts, graphs, frequency tables, measures of central tendency, and probability calculations

Other activities that can be used to develop thinking skills in the FOM class could include:

Lessons that direct students to activities outside the classroom:

- estimating and measuring objects in the environment as applications of mathematics
- collecting data from real situations to develop skills in analyzing a task and making what, how, and why decisions.

Problem-solving strategies that require students to think through a problem and choose an intelligent approach to solve it:

- estimating the answer before solving the problem
- drawing a diagram to illustrate the information given
- making or using a model
- looking for a pattern
- guessing and checking
- solving a related but simpler problem

Situational lessons in which a problem describes an interesting, challenging situation from which numerous mathematical activities or problems emerge.

A broad range of applications.

Process

Teaching students how to be active problem solvers requires moving from a daily lecture-and-seatwork mode to using instructional strategies that engross and amuse students. Examples follow:

Working in small groups

To learn thinking skills and know how and when to use them, students need opportunities to discuss their work. Research indicates that dividing classes for small-group activities is a convenient, productive way to provide this discussion. The interaction of students working on a common task can facilitate the development of thinking skills through shared problem solving, enhance motivation, and increase interest in course content. Group discussions should include not only the "right" answer, but the process by which they arrived at the answer and their reasons for thinking it correct.

If groups are assigned the same problems, they can each present their solution to the rest of the class. Groups could use a model, written solution, or illustration on a transparency. Class discussion of alternative strategies is a crucial part of the process of learning how to solve problems. Students need to see a variety of correct solutions for the same answer and understand that they are all acceptable.

Questioning techniques

How a teacher phrases a question can make a big difference in the quality of a student's response. If teachers ask questions for which there is only a one-word answer, students need only respond with recall information or computational answers. Varying the types of questions enriches learning for both the teachers and students.

Questions can be phrased to:

- Determine student misconceptions
- Learn the different methods they use to solve problems
- Help them become aware of and describe their thinking as they solve problems
- Encourage them to use correct mathematical language

- Make them realize they are not alone in their misconceptions and wrong answers
- Diagnose their understanding of content and concepts
- Increase both the quantity and quality of their communication from one-word answers to explanations and analysis

Increasing Wait Time
Remedial students need more wait time than average students to think through and answer a question. By increasing wait time, teachers convey confidence in a student's ability to supply answers. If a student cannot respond, the teachers should rephrase the question, or ask another leading question, and wait again.

Manipulatives and Models
Concrete materials can be used to present concepts, pose problems, and model solutions. Models help students form mental images or visualize problems when they are trying to think through a problem.

Calculators
Using calculators allows students to concentrate on the process rather than on computation; thinking through a problem is more important than the answer.

Product

Having adjusted content and process variables, what expectations should teachers have of remedial students?

FOM students should be able to:

- Look at problems in different ways and consider alternative solutions
- Explain, describe, discuss, and defend their solutions to problems
- Feel free to be wrong
- Be able to use their computational skills as tools to solve problems
- Become aware of mathematical interrelationships across several areas of mathematics
- Improve their ability to think and talk about mathematical concepts and relationships

These outcomes for remedial students are often overlooked, especially when the goal is only to raise test scores. Yet, scores on all course objectives will improve if teachers replace dull, repetitive, drill-and-practice instruction with motivating activities that are fun and thought-provoking. Then, FOM students, like other students, will be more likely to learn, like, and use mathematics.

Reference List:

Laycock, M. & Smart, M. 1984. *Hands on Math for Secondary Teachers*, Hayward, CA: Activity Resources Co. Inc.

Sobel, M. & Maletsky, E. 1975. *Teaching Mathematics: A Source Book of Aids, Activities, and Strategies*, Englewood, Cliffs, NJ: Prentice-Hall Inc.

READING

REALISTIC
EDUCATIONAL
ACHIEVEMENT
CAN
HAPPEN

THINKING AND LITERATURE: A PLAN FOR PREKINDERGARTEN AND KINDERGARTEN TEACHERS

Written by—
Amie Beckett,
Prekindergarten and
Kindergarten Specialist

In literate societies, writing and thinking have been interwoven throughout history. Literature and other written material have provided the basis for higher level thinking in those cultures, because they allow for the storage and retrieval of large quantities of information and facilitate the comparison of ideas.

Because literature provides so many opportunities for extending sensory and early conceptual learning, it plays a powerful role in developing young children's thinking. Children learn about the world by actively manipulating and interacting with the environment; in turn, sensitive adults provide language to help them understand and talk about what they have observed. By interacting with the environment, young children are able to understand new information and express themselves in increasingly succinct ways. By interacting with the environment, children learn to enjoy literature naturally, just as they learn oral language.

Higher level thinking is facilitated through language development; sensory information is coded into language that provides the basis for generalization and classification in concept development. A child who develops concepts and language in this way has a long-term advantage over one who has had a less supportive environment for language exploration.

Literature is essential to the process of language development and critical thinking for these reasons:

- It provides a fictional account of everyday events that expose children to other viewpoints. This exposure enables a young child to take the first steps beyond egocentrism to understanding viewpoints other than his own. A child who listens to a story, and begins to

Because literature provides so many opportunities for extending sensory and early conceptual learning, it plays a powerful role in developing young children's thinking.

empathize with the pain of a young bird that has lost its mother, is beginning to develop a sense of events beyond his life. This is an important step in cognitive development.

- It provides children with a medium for creative play. Children may play with words in stories, dramatize them with their own embellishments, and create their own stories based on the literature and their own experiences.
- It helps to develop a type of oral and written language that Jim Cummins refers to as "cognitive-academic language proficiency." This language contrasts with "basic interpersonal communication," which is used in casual speech. The primary distinguishing feature of cognitive-academic language is its lack of reliance on the context surrounding the language. Children possessing a high degree of this type of language are not dependent on words that describe what they are experiencing at the moment. Their level of concept development allows them to understand language that describes different people, events, or times.

Recent research indicates that the degree of exposure to literature at home may affect language development and subsequent academic success. One group of children studied by Shirley Brice Heath had limited exposure to literature; they were given alphabet books and expected to learn letter names and sounds, numerals, and other fragmented bits of information. These children performed well in the early grades, but their achievement later declined markedly. Another group in Heath's study—children from homes in which literature was regularly shared and discussed— maintained steady growth in academic achievement.

Schools may ensure some of the same types of positive exposure to literature by structuring the environment for teacher-directed and self-directed activities. Before children are able to interact independently with books, develop themes in dramatic play, and create artwork or invented spellings in stories, the teacher can stimulate higher level thinking in directed activities. Activities that follow outline strategies a teacher might use in presenting a story to preschoolers.

One example of a story that lends itself to teaching the process of synthesis is *Chickens Aren't the Only Ones*, by Ruth Heller. To illustrate how this story might be used by teachers of young children, this article will define synthesis, state why students should be taught to synthesize, then provide strategies for incorporating synthesis into the literature program. These strategies are equally suitable for older elementary students.

Synthesis

What is synthesis?

Synthesis can be defined as "the putting together of elements and parts so as to form a whole. This is a process of working with elements, parts, etc., and combining them in such a way as to constitute a pattern or structure not clearly there before." (Bloom) To synthesize, students must first understand how the information they are reading is organized. That information must then be summarized. Throughout the process of synthesis, students use both the information found in the text and the information known about the subject prior to reading the text. In other words, synthesis enables students to integrate large amounts of new information into fewer words. The ability to synthesize helps them organize information into patterns or graphic forms. (see figure 1)

Why teach students to synthesize?

Synthesizing helps students:

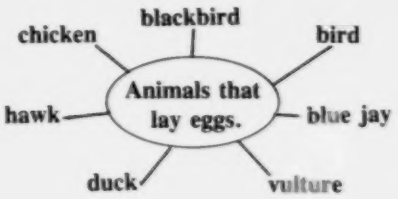
- organize new information
- summarize information
- integrate new information with prior knowledge

Strategies for Helping Students Synthesize Information using *Chickens Aren't the Only Ones*, by Ruth Heller

Story synopsis: Starting with a familiar bird, the chicken, the author leads children and adults through a set of pictures and rhymes revealing factual information about many adult animals—birds, reptiles, amphibians and fish—that have their young by laying eggs.

1. Ask students to name all the animals they can think of that lay eggs.
2. Record their responses in a story map or web format on a chart or chalkboard. *(see step 1 in figure 1)*
3. Read *Chickens Aren't the Only Ones*.
4. Discuss additional animals that lay eggs.
5. Record student responses by adding new information to the story map or web. *(see step 2 in figure 1)*
6. Discuss the groups of animals listed on the story map or web.
7. Guide students to group the animals by their means of locomotion.
8. Record their responses in a story map or web format on a chart or chalkboard. *(see figure 2)*
9. Have students summarize the information recorded on the story maps or webs and record this information for future use.

Step 1



Step 2

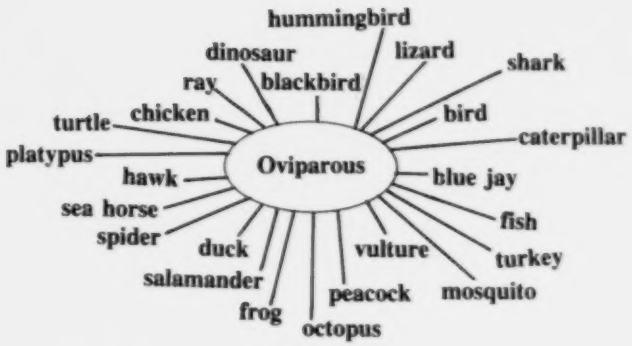
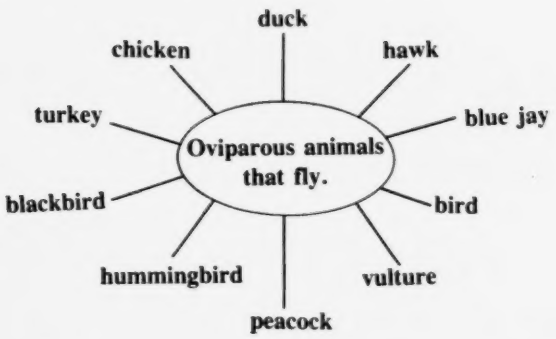
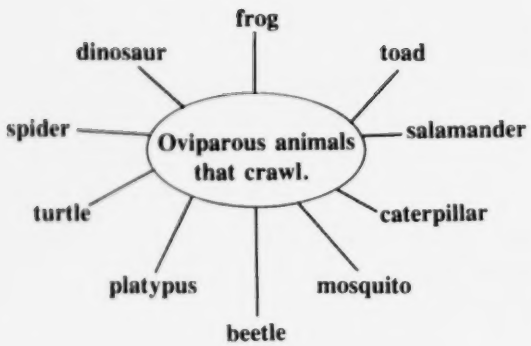


Figure 1

By interacting with the environment, young children are able to understand new information and express themselves in increasingly succinct ways.





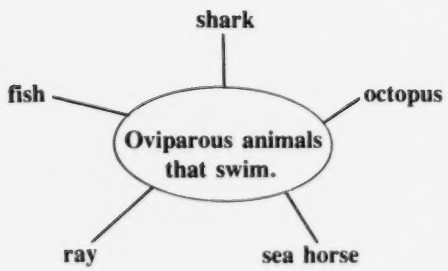


Figure 2

Other examples of children's literature that are suitable to use with this strategy include:

- Francine Patterson, *Koko's Kitten*
- Robert McCloskey, *Make Way for Ducklings*
- Robert McCloskey, *Blueberries for Sal*
- Eric Carle, *The Very Hungry Caterpillar*
- Eric Carle, *The Very Busy Spider*
- Lynd Ward, *The Biggest Bear*
- M.M. Dee, *The Adventures of L.A.*
- Tomie dePaola, *Kids Cat Book*

An example of a story that can be used to discuss strategies for teaching children to predict is *The Napping House*, by Audrey Woods. This section will define prediction, state why students should be taught to predict, then providing strategies for incorporating prediction into the study of literature.

Prediction

What is prediction?

Prediction, which involves anticipating future events, includes both convergent thinking (moving toward a common point), and divergent thinking (moving in different directions from a common point) about what might happen next. Guszak suggests that convergent thinking, which calls for the expected, is used in response to printed and pictorial cues. Divergent thinking, on the other hand, calls for the unexpected; that is, the person predicting will use creative thinking to envision the outcome.

When readers predict, they must organize and summarize information gathered up to a turning point in the story. They must then evaluate information using both the information

presented in the text and prior knowledge about the information. Finally, readers elaborate characters or possible events and outcomes based on evaluation of the text.

Why teach students to make predictions before and during the story?

Predicting helps students:

- organize and summarize information
- evaluate information
- transfer prior knowledge to new situations
- elaborate characters or events and outcomes

Strategies for Helping Students Make Convergent and Divergent Predictions using *The Napping House*, by Audrey Woods

Story Synopsis: On a rainy afternoon Granny takes a nap, and soon others in the room decide to join her. Each character in the story piles one on top of the other on the cozy bed. All through the story, we see a tiny black dot—a wakeful flea—that sets off a chain reaction reversing the sequence of events. The story is similar to the familiar nursery rhyme: "This Is The House That Jack Built."

1. After reading the title, ask students what they think a napping house is and why.
2. Share the picture on the first page with students. Have them suggest activities that might take place in this kind of weather.
3. Begin reading. Have students examine the picture on the fourth page. Ask students to predict what the boy will do next.
4. As the teacher reads each page, have students predict who will be next to join the group on the cozy bed, and have them explain their reasons. Invite many responses. Let students know there are no wrong or right answers. As more clues are revealed in the story, encourage students to change or modify their predictions.
5. On the page where the wakeful flea is introduced, have students predict what the flea will do.
6. As the story continues, have the students predict how each character wakes the next.
7. After reading the page where Granny breaks the bed, ask students to tell how they think the story will end.

Other examples of children's literature that are suitable for use with this strategy include:

- Bill Gillham, *What Happens Next?*
- Charlotte Zolotow, *Little Rabbit and the Lovely Present*
- Jan Ormerod, *Sunshine*
- Laura J. Numeroff, *If You Give A Mouse A Cookie*
- Steven Kellogg, *The Island of the Skogg*

Summary

Synthesis and prediction are two types of higher level thinking that may be taught using literature. Other levels of higher thinking are stimulated if children are encouraged to interact with literature by themselves, with other children, or with a skilled teacher who will help them expand their understanding of the text and provide them with language that describes their insights. This thought is supported by Margaret Donaldson, in *Children's Minds*: "The hope, then, is that reading can be taught in such a way as to greatly enhance the child's reflective awareness, not only of language as a symbolic system, but (also) of the processes of his own mind."

Higher level thinking is facilitated through language development; sensory information is coded into language that provides the basis for generalization and classification in concept development.

Essential Elements used to Illustrate Strategies for Synthesis and Prediction

Prekindergarten

COMMUNICATION DEVELOPMENT

- Listening (receptive language)
  - respond to simple directions, commands, and questions
  - acquire the meaning of vocabulary words related to concepts being presented
  - listen to literary selections daily for personal enjoyment
  - become aware of various speech sounds and patterns through rhymes, poems, chants, and fingerplays
  - respond to storytelling or oral reading by telling what the story is about, recalling facts and details, and recalling the sequence of events
  - focus on a speaker without interruption
  - recognize voice tone as a way to express feeling
- Speaking (Expressive language)
  - use a variety of words to express feelings and ideas
  - talk about what is seen, heard, touched, tasted, or smelled as objects, people, and events are experienced
  - engage in a conversation by sharing ideas with others
  - dictate ideas and feelings as they are recorded
  - speak clearly
  - use oral language in a variety of situations

COGNITION DEVELOPMENT

- Identifying
  - describe phenomena in the environment (science)
- Comparing and Contrasting
  - compare similarities and differences among objects using taste, smell, sight, and sound
- Classifying
  - form groups by sorting and matching according to their attributes
  - combine and separate groups of objects to form new groups
  - sort objects from the environment according to one or more characteristics (use composition and location, for example)
- Predicting cause/effect relationships
  - know and discuss the consequences of actions in social relationships

Kindergarten

- Listening
  - focus attention on a speaker without interruption
  - listen to appreciate sound devices of rhythm, rhyme, alliteration, and onomatopoeia
  - listen carefully to instructions and important information
- Speaking
  - use a variety of words to express feelings and ideas
  - speak clearly and at an appropriate rate
  - communicate effectively in one-to-one and small group situations
  - relate events from personal experience
- Reading
  - understand the direction of conventional print
  - relate experiences with appropriate vocabulary in complete sentences
  - respond to storytelling or oral reading by telling what the story is about, recalling important facts and details

Before children are able to interact independently with books, develop themes in dramatic play, and create artwork or invented spellings in stories, the teacher can stimulate higher level thinking in directed activities.

- follow oral directions
- develop literary appreciation skills to provide personal enjoyment
- appreciate repetition, rhyme, rhythm, alliteration
- respond to various forms of literature
- follow simple story line in stories read aloud

- Writing
  - use a variety of techniques to select topics and to generate material to write about those topics
  - recognize that writing can entertain and inform

- Language
  - develop skill in using the grammar of English for effective oral and written communication
  - use oral language in a variety of situations

- Art
  - discover line, color, shape, and texture by seeing and feeling objects (K-6)

- Science
  - observe events and changes in the environment
  - use classification skills in ordering and sequencing data
  - classify objects by comparing similarities and differences
  - experience in oral and written communication of data in appropriate form

Reference List:

Bloom, B. 1956. *Taxonomy of Educational Objectives, Handbook I: Cognitive I Domain.* New York: David McKay Company. 162.

Cummins, J. 1979. Cognitive-academic language proficiency, linguistic interdependence, the optical age question, and some other matters. Working Papers on Bilingualism, 19. 197-205.

Donaldson, M. 1978. *Children's Minds.* New York: W.W. Norton and Company.

Guszak, F. 1985. *Diagnostic Reading Instruction in the Elementary School.* 3rd edition. New York: Harper and Row. 109-110.

Hammond, D., Nessel, D. & others. 1985. *Reading Comprehension: Making Every Child a Winner.* Rochester, MI: Learning Institute, Oakland University.

Heath, S. 1982. *What No Bedtime Story Means: Narrative Skills at Home and School.*

Martin, B. 1987. "The Making of a Reader: A Personal Narrative." In Bernice Cullinan. ed. Children's Literature in the Reading Program. Newark, DE: International Reading Association, Inc. 15.

THINKING AND LITERATURE: A PLAN FOR SEVENTH AND EIGHTH GRADE READING IMPROVEMENT

Written by
Catherine Davis
and
Margaret Paulissen,
Reading Specialists

A classroom environment that enables students to learn about the process of thinking is a place rich in literacy events. These classrooms have teachers who read to the class, allow students extended time to read on their own, and give students opportunities to respond to their reading by writing. Students learn in a setting that goes beyond simply teaching reading skills to providing activities that incorporate higher order thinking. Reading and writing provide the avenue for thinking; literature provides the content. In such an environment, at-risk seventh and eighth grade reading improvement students are motivated to learn.

Teaching higher order thinking strategies requires the teacher to direct students to access information that may not be explicitly stated. Learning these strategies is critical, as many remedial students have difficulty comprehending implicit information. While successful junior high readers have acquired thinking strategies that help them easily understand most text they read, many reading improvement students have not. More importantly, successful readers are able to use these thinking strategies in a variety of situations.

Teaching any thinking strategy requires content to think about. Therefore, thinking is easily taught within an area like literature because it provides an avenue for helping students use their language for such functions as summarizing, predicting, explaining, synthesizing, and elaborating. To use language in this way, students must be able to understand information that is implied.

This article will explain one way to teach remedial reading students to predict events in a story and to synthesize complicated information. These strategies, which are equally

Students learn in a setting that goes beyond simply teaching reading skills to providing activities that incorporate higher order thinking. Reading and writing provide the avenue for thinking; literature provides the content.

suitable for all other secondary students, will be broken into their component parts, and suggestions will be given for systematically learning these processes until they become automatic.

A story that lends itself to teaching the process of synthesis is *The Gift of the Magi* by O. Henry. To illustrate how this story might be used by Reading Improvement teachers, this section will define synthesis, state why students should be taught to synthesize, and provide strategies for incorporating synthesis into the literature program.

Synthesis

What is synthesis?
Synthesis can be defined as "the putting together of elements and parts so as to form a whole. This is a process of working with elements, parts, etc., and combining them in such a way as to constitute a pattern or structure not clearly there before." *(Bloom)*

To synthesize, students must first understand how the information they are reading is organized. That information must then be summarized. Throughout the process of synthesis, students use both the information found in the text and the information known about the subject prior to reading the text. Synthesis enables students to integrate large amounts of information into fewer words and into patterns or graphic forms. *(see figure 1)*

Why teach students to synthesize?
Synthesizing helps students:

- organize new information
- summarize new information
- integrate new information with prior knowledge

Strategies for Helping Students Synthesize Information using *The Gift of the Magi*, by O. Henry

Story synopsis: It's Christmas Eve, and Jim and Della, a young couple without much money, make the ultimate sacrifice to buy each other gifts. Della cuts and sells her ravishing locks to buy a watch fob for Jim, and Jim sells the gold watch inherited from his grandfather to buy tortoise hair combs for Della.

1. As a prereading activity, initiate a discussion about gift giving. Ask students:
   - To whom do you give gifts?
   - Why do you give gifts?
   - Do gifts always cost money?
   - What special gifts can we give to special people?
2. Read the story.
3. Discuss the main idea of the story. Help students map the pattern of events in a story map. *(see figure 1)*
4. Help students develop a general pattern. *(see figure 2)*
5. Write a synopsis with students based on the story map and general pattern. *(see example)*
6. Assist students until they can perform this skill independently.

Other examples of literature that are suitable to use with this strategy include:

- *Legend of the Bluebonnet* retold by Tomie dePaola
- *Sarah Plain and Tall* by Patricia MacLachlan
- *The Day the Sun Came Out* by Dorothy M. Johnson

General Pattern based on *The Gift of the Magi* by O. Henry

FIGURE 1

Story map based on *The Gift of the Magi* by O. Henry

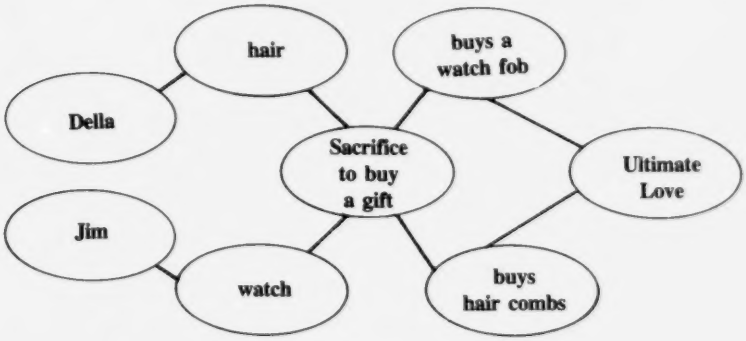


FIGURE 2

Example

A young couple desires to give each other special gifts for Christmas. Each makes an ultimate sacrifice of love to purchase the gifts. Ironically, the sacrifice makes the respective gifts useless.

Synopsis based on the story "The Gift of the Magi" by O. Henry

Prediction

Prediction is another useful thinking process. This section will define prediction, state why students should be taught to predict, and provide strategies for incorporating prediction into literature.

What is prediction?
Prediction involves anticipating future events and includes both convergent and divergent thinking about what might happen next. In reading, Guszak suggests that convergent thinking, which calls for the expected, is used in response to printed and pictorial cues. Divergent thinking, on the other hand, calls for the unexpected; that is, readers use creative thinking to envision the outcome.

To predict, readers must organize and summarize information gathered up to a turning point in the text. They must then evaluate that information using both facts presented in the text and prior knowledge about those facts. Finally, readers elaborate characters or possible events and outcomes based on their evaluation of the text.

While successful junior high readers have acquired thinking strategies that help them easily understand most text they read, many reading improvement students have not. More importantly, successful readers are able to use these thinking strategies in a variety of situations.

Why teach students to make predictions before and during the story?
Predicting helps students to:

- organize and summarize information
- evaluate information
- transfer prior knowledge to new situations
- elaborate characters or events and outcomes

Strategies for Helping Students Make Convergent and Divergent Predictions using *The Dinner Party*, by Mona Gardner.

Story synopsis: Guests at the dinner party of a colonial official in India discuss the inability of women to control their emotions in times of crisis. The hostess disproves this theory by her calm reaction in the face of danger.

1. Read the title of the short story. Have students:
   - discuss the difference between a dinner party and dinner with the family
   - list the kinds of conversations that might take place at a dinner party
   - state why they think these conversations might occur (list students' predictions on the board)
2. Read the first paragraph. Then ask the students if knowing the makeup of the group might make a difference in what they think the guests are discussing. (add the differences to the list)
3. Read paragraphs 2-5. Ask students:
   - What is happening?
   - Why might the hostess be staring straight ahead with a strange expression on her face and her muscles contracting slightly?
   - Why did the servant place a bowl of milk on the veranda?
   - What might you expect the women to do?
   - What might you expect the men to do?

   (list students' responses on the board)
4. Read the remainder of the story. Then ask what might have happened if the hostess had not remained calm.

   (list students' responses on the board)
5. Compare the list of predictions on the board and the events of the story. Ask students what information in the story changed their predictions.

6. Ask the students to brainstorm other possible endings for the story.
7. Have students think of other situations where it is important to remain calm in the face of danger. The strategy used above, sometimes referred to as a "directed reading thinking activity," asks students to use their background knowledge while reading the text. As students begin to think about the selection, to predict what might happen, and to tie this information to what they already know about similar situations, they are using divergent thinking. While they read or listen to new information, they must change their existing predictions to fit the text. As their predictions change, a more convergent line of thinking emerges. Teacher activities following the story, such as asking students to brainstorm other possible endings, provide another opportunity to promote divergent thinking. These strategies help students assimilate the new information into their existing knowledge.

Other examples of literature that are suitable to use with this strategy include:

- *The Flying Machine* by Ray Bradbury
- *Zlateh the Goat* by Isaac Asimov
- *Anansi the Spider: A Tale from the Ashanti* retold and illustrated by Gerald McDermott.

Summary

Beyond its usefulness as a vehicle for teaching processes like prediction and synthesis, sharing high quality literature with students influences them in many ways. Good literature, whether read to the students or read by them, not only introduces them to new material, but also acquaints them with the form and structure of language. Such exposure broadens their experiences with the world, increases their opportunities to learn life skills, and enhances their use of language.

Essential Elements used to Illustrate Strategies for Synthesis and Prediction

Reading Improvement Grade 7:

- Word attack skills to decode written language
  - use contextual clues
- Comprehension skills to gain meaning from whatever is read
  - select the directly stated or implied main idea in paragraphs and in longer selections
  - recognize specific facts and details supporting the main idea
  - make inferences and draw conclusions
  - perceive cause and effect relationships
  - predict probable future outcomes or actions

Reading Improvement Grade 8:

- Word attack skills to decode written language
  - demonstrate basic word attack skills: contextual clues
- Comprehension skills to gain meaning from whatever is read
  - identify the implied main idea
  - choose supporting facts and details
  - perceive cause and effect relationships
  - summarize and make generalizations
  - analyze information and make judgments on the basis of information given

Reference List

Bloom, B. 1956. *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain.* New York: David McKay Company, 162.

Hammond, D. & others. 1985. *Reading Comprehension: Making Every Child a Winner.* Rochester, MI: Learning Institute, Oakland University.

Guszak, F. 1985. *Diagnostic Reading Instruction in the Elementary School.* 3rd edition. New York: Harper and Row, Publishers. 109-110

SCIENCE

REALISTIC
EDUCATIONAL
ACHIEVEMENT
CAN
HAPPEN

ELEMENTARY SCIENCE: *REACH*ING EXCELLENCE

Written by
Barbara ten Brink,
Science Specialist

Scientific investigation is inquiry. It is trial and error. It is searching for solutions. It is invention. It is decision making. It is engaging in higher level thinking.

By participating in hands-on activities, elementary students receive the "minds-on" stimulation they need to solve problems. By testing strings, pullies, inclined planes, wheels and axles, and various weights, students are motivated to investigate questions like: What is the most efficient way to move this load? Working in small groups or individually, they proceed to find answers.

Chapter 75 mandates a balance of content and activities in the life, earth, and physical sciences for elementary students. This balance ensures that these students spend at least half their time investigating questions and finding solutions in their classrooms, on campus, or in their community. An examination of the science essential elements and scientific investigation illustrates their relevance to higher level thinking.

Essential Element 1:
Manipulative Laboratory Skills

Students develop eye-hand coordination by doing science activities safely. In kindergarten, students string beads according to attributes, pour sand and water, and explore textures, among other activities.

In other elementary grades, students manipulate hand-made, commercial, and environmental objects, and measuring devices. As students are given opportunities to manipulate objects, they become involved with the other essential elements. From hands-on experiences, they progress to identifying problems, designing operations to investigate those problems and, eventually, determining the best solution.

By participating in hands-on activities, elementary students receive the 'minds-on' stimulation they need to solve problems.

Essential Element 2:
The Use of Skills in Acquiring Data Through the Senses

The primary grades are excellent years to encourage students to use all of their senses to observe phenomena. In kindergarten, they observe their immediate surroundings, explore their senses and sense organs, and notice similarities and differences in their environment. Intermediate students expand their skills by observing phenomena over a period of time. Microscopes, models, simple machines, living things, and community resources are tools used to gain visual data leading to solutions.

Essential Element 3:
The Use of Classification Skills In Ordering and Sequencing Data

Primary students classify objects from their environment, then explain their reasons for a particular scheme. The teacher accepts the student's answer and then designs activities to further develop the child's concepts. Students also sequence their daily activities. Intermediate students design more elaborate classification schemes and, with teacher guidance, begin to use classification schemes generally accepted by scientists. They also sequence the steps in experimental investigations.

Essential Element 4:
Experience in Oral and Written Communication of Data In Appropriate Form

Teachers provide opportunities for primary students to share experiences, thus building oral language communication. To communicate their data in written form, students might mark their heights on a life-sized bar graph, or the teacher could write the data on a story board. Intermediate students describe and interpret the phenomena they have observed, reporting their data and conclusions orally. They display their data pictorially in tables, graphs, charts, and histograms, or write reports.

Essential Element 5:
Experience in Concepts and Skills of Measurement Using Relationships to Standards

Beginning in grade 1, students make measurements in relation to a standard. For example, students might measure the height of their chairs or desks using strung paperclips or spoons as the standard. Toward the end of grade 1 and throughout their school career, students use the metric system for gathering data.

Essential Element 6:
The Use of Skills in Drawing Logical Inferences, Predicting Outcomes, and Forming Generalized Statements

The teacher's questioning strategies play a vital role in helping students develop the skills named in this element, which is introduced in grade 2. The teacher asks if-then and cause-and-effect questions. Questions that ask, "What might happen if...?" and "What do you think caused...?" help students make predictions and inferences. Students form generalized statements to describe the phenomena they observed.

Essential Element 7:
Experience in Skills in Relating Objects and Events to Other Objects and Events

This essential element, introduced in grade 4, offers opportunities for analogical reasoning as students relate the experiences or experiments to one another. Concepts presented in the classroom reflect the larger world. For example, maintaining animals in the classroom can be related to maintaining pets at home, wild specimens in zoos, and livestock on ranches and farms. This strategy reteaches or enriches science concepts.

Essential Element 8:

Experience in Applying Defined Terms Based on Observation

Fourth grade students begin to apply technical terms to the phenomena they have experienced. While conducting an activity, they invent terms that describe what they have observed. The teacher guides them toward more sophisticated language until, finally, the students have an accurate definition. Scientific terms do not seem overly technical if students base definitions on their own experiences.

Essential Element 9:

Experience in Identifying and Manipulating the Conditions Of Investigations

The experiment is the heart of science. When students begin to understand the nature of variables and, by changing them, change the conditions of an activity, they are participating in a science experiment. In groups, students establish control and experimental variables, gather data, and collaborate to reach a final conclusion.

Essential Element 10:

Application of Science in Daily Life

Students are given opportunities to explore the relevance of science and technology to their daily lives. They research current topics related to the question they are studying. They make consumer and career choices related to social and civic responsibilities.

Linking the Essential Elements

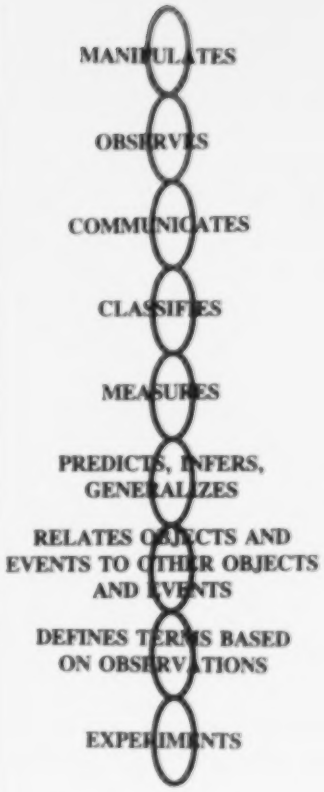
To stretch thinking opportunities for students, the science essential elements are taught as a continuum. Each element is taught in concert with other elements. For example, when students ***manipulate,*** they also manipulate to ***acquire data through their senses.*** They ***communicate their data orally*** by sharing ideas with group members and the class, and they also ***communicate their data in an appropriate written form*** on tables, graphs, charts, and in reports. Students ***classify*** their material according to characteristics and their data according to a scheme. They take ***measurements*** to refine their information. Before all data are gathered, they ***make predictions*** about the outcome of the study; after, they draw ***inferences.*** Students are able to discuss in ***generalized statements*** what is occurring within the study.

The class ***relates the objects and events of the experiment to other objects and events.*** They extend the experiment to further experimentation or to life situations. They ***define terms based on their observations*** of the phenomena and apply them during the experiment. To experiment, students ***identify the variables*** that may affect the outcome, then ***manipulate one or more variables while holding the other variables constant.*** Because science is such a dominant influence in our daily lives, ***application of the study to their daily lives*** is imperative.

Not every science lesson lends itself to using all essential elements. Lesson objectives should determine the depth to which essential elements are explored and the sequence and number of essential elements used during the lesson.

Searching for Solutions

Science lessons always begin with the development of a question. The teacher may get an idea from the students' curiosity, a previous lesson, or the curriculum guide. Once the question is developed, students search for answers by manipulating materials, cooperating with fellow students, and designing experiments. They may investigate, assemble collections, construct models, or verify scientific principles.



The experiment is the heart of science. When students begin to understand the nature of variables and, by changing them, change the conditions of an activity, they are participating in a science experiment.

In an investigation, students design experiments by establishing control and experimental variables. "Does exercise increase heart rate? Do different areas of the school campus support different species? Which materials make the best conductors or insulators of electricity?" These and other questions require students to compare data.

Students may assemble collections to answer questions like these: "Which of these objects are attracted to magnetism? What characteristics do they share? How is the venation of leaves used to classify leaf shape?" Collections of photographs answer many questions about similarities and differences when collecting the actual object would be impossible. Organisms that are protected or are native to certain parts of the world, objects that are huge or microscopic, and various geological formations may be "collected" by using photographs.

Models are used to find solutions to such questions as, "Which type of insulation used in these model homes is the most efficient?" or "What is the alignment of the earth, moon, and sun during a solar or lunar eclipse?"

Questions are also answered when students verify scientific principals. "How does Newton's third law of motion relate action and reaction?" or "How does friction affect a moving object?" are common ideas tested through scientific methods.

To organize their thoughts and data, students record them. Maintaining a lab book gives them the feeling of working like scientists, puts complicated processes into concrete form, enables them to share ideas with their peers, and allows them to reflect on subsequent but related activities. Students could record their data on a form like this one:

Data Collection Form Example

Statement of a Question
A question begins the quest for a solution. It narrows the problem by bringing it into focus. From the beginning of the investigation, students know what they are trying to prove.

Hypothesis
The hypothesis is one possible solution to the problem. It is the students' best guess of what they think will happen.

Materials
Objects necessary to conduct the activity are used.

Research
Students bring as much information to the experiment as possible. They look for supporting evidence in texts, libraries, and community resources.

Procedure
Step-by-step methods are recorded. Some information includes:

Experimental Data
Students test their hypothesis by establishing control and experimental groups to test the variables. Will the experiment support the hypothesis or disprove it?

Results
Students make careful measurements. They record their data on charts, graphs, and histograms. They analyze the data to see if there are any inconsistencies. Were all variables controlled or manipulated, or did the students identify variables they had not thought of before?

Conclusion
What did students learn from the experiment? Was the hypothesis supported? If so, why was the experiment important? If the hypothesis was not supported, must the question be restated? What variable could have skewed the data? What questions did the students generate while working on this problem? Did all students agree in their results?

Science Experiment Example

Statement of a Question
How does Newton's third law of motion relate action and reaction?

Hyopothesis
Action and reaction are related laws of motion.

Materials
- 5 meters of string
- one straw
- balloons
- tape

Research
Students research the topic by interviewing people and exploring libraries and community resources.

Procedure
- Thread the string through the straw
- Affix the inflated but untied balloon to the straw using tape
- Release the balloon
- Observe what direction the balloon traveled
- Measure the distance the balloon traveled
- Repeat the experiment

Experimental Data
a. Illustration of the path of the balloon along a trajectory

b.

Test	Distance the balloons travel in meters
A	
B	
C	

Results

Test A	was inconclusive because we had difficulty holding the balloon.
Test B	travelled 5 meters. We need a longer string.
Test C	travelled 10 meters.

Summary

Our hypothesis was supported because the action of air escaping from an inflated balloon caused a reaction that pushed the balloon along a trajectory. Would "multistage rockets" of more than one balloon travel a greater distance? What would happen if two balloons were affixed in opposite directions?

Conclusion

Science taught as investigation preserves the natural curiosity of children, encourages peer interaction, enhances creativity as students design experiments, prepares elementary students for the transition to secondary science courses, helps students develop skills useful in other study areas, and prepares them for problem solving in later life. Within the informal, small-group activities of elementary science, young students learn to work cooperatively, appreciate and enjoy science, and implement the processes used by scientists.

Effective science teaching motivates students to investigate their environment through trial and error, problem solving, invention, and decision making. The task of science educators is to provide the environment that best motivates children to stretch beyond simple right and wrong answers, to take risks to find solutions, and to enjoy themselves as they REACH for science excellence.

Reference List

Cohen, M. & Flick, L. eds. December 1981. *Expanding Children's Thinking Through Science: CESI Sourcebook II.* The Council for Elementary Science, International, ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, Ohio.

"Educating Americans for the 21st Century: A plan of action for improving mathematics, science, and technology education for all American elementary and secondary students so that their achievement is the best in the world by 1995." The National Science Board Commission on Precollege Education in Mathematics, Science, and Technology, September 1983.

Science Framework: Kindergarten through Grade 12. September 1987. Texas Education Agency.

Yager, R. September 1987. "Wanted: More Questions. Fewer Answers." Science and Children. 25:1.

"Your Guide to Science Fair Projects: From Idea to Exhibit." 3rd Edition. 1984. Public Affairs Department-Educational Services, Public Service Company of New Mexico.

THINKING SKILLS AND SECONDARY SCHOOL SCIENCE

Written by
Kamil Jbeily,
Science Specialist

...the practice of engaging students in developing higher level thinking is the crucial instructional issue.

This article discusses higher level thinking in the following categories: definitions, instructional strategies, testing, and examples from the high school science curriculum.

What are Higher Level Thinking Skills?

Even researchers find it tough to get hold of the question: Just what is a higher level thinking skill? And—supposing the question is answered—how would educators really know they're teaching them effectively? And, once they've been taught, how would they know what students have learned? Champagne summarizes the state of the science by saying: "Improved instruction and assessment of higher order cognitive skills are contingent on developing operational definitions of those skills."

Nevertheless, researchers have made some headway in identifying the skills and attributes that constitute higher level thinking. They are: identifying and solving problems, testing consequences of possible solutions, observing and judging observations and events, gathering and interpreting scientific data, comparing and contrasting, classifying and categorizing, grouping and labeling, predicting and making decisions, inferring and drawing conclusions, questioning and thinking critically, generalizing and relating parts to the whole, identifying hierarchy and family relations, ordering, patterning, prioritizing, and synthesizing information. (Kearney and others)

Champagne uses two systems for sorting these skills. One system sorts them into tasks—problem solving, learning, and inquiry—and the other system sorts them into the subject in which they are demonstrated. In the system related to tasks, students compare new problems with different categories of problems from their background. The similarities bet-

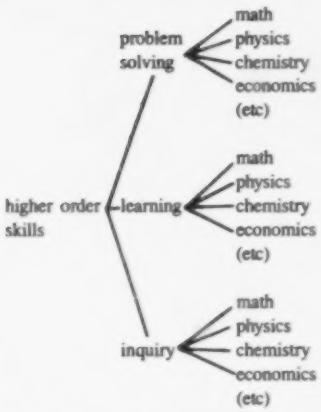
ween current and previous problems provide the method for solving the new problem.

In the system related to disciplines, students use their background knowledge about a subject, then restructure it to interpret events and solve problems. Figure 1 illustrates the two systems.

FIGURE 1

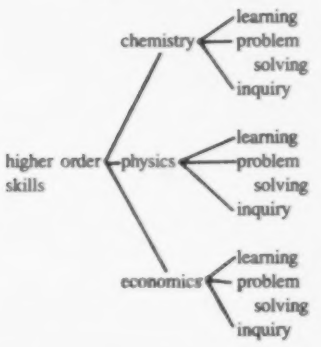
Higher Order Cognitive Skills Sorted According to Task

TASK SPECIFIC



Higher Order Cognitive Skills Sorted According to Discipline

DISCIPLINE SPECIFIC



Regardless of whether these skills are taught through tasks or subjects, or in an independent thinking skills course, the practice of engaging students in developing higher level thinking is the crucial instructional issue. Students need to be taught "to think critically, assertively, and habitually." *(Kearney)*

Instructional Strategies

Instructional strategies used to develop higher level thinking demand appropriate questioning techniques. The focus of scientific questioning is, after all, to help students reach their own personal conclusions or reasonable explanations of events and phenomena. Rote memorization, drills, and "practice makes perfect," neither enhance this instructional strategy nor a student's ability to think critically. What does is the students' open-minded willingness to question the why, what, how, and how much, as they probe, investigate, and act to solve complex problems.

The essential elements for science emphasize the higher level thinking skills of observing, data gathering, manipulating equipment and variables, categorizing, grouping and labeling, classifying, comparing and contrasting, making inferences, drawing conclusions, and predicting outcomes, among others.

Teaching the essential elements in science *is* teaching higher level thinking. The fact that these skills are embedded in the science curriculum helps all students, regardless of their abilities or achievement levels, engage in higher level thought. When learning science, all students—remedial, average, and gifted—classify, compare and contrast, infer, predict outcomes, and apply concepts.

Thinking scientifically, which is the gist of learning and practicing science, is the essence of higher level thinking. The sequential process of identifying and stating a problem, collecting information and data about the problem, hypothesizing, experimenting to test the hypothesis, recording and analyzing data, and drawing a conclusion, is by nature a highly cognitive process.

Teachers, however, cannot and should not teach higher level thinking to the exclusion of other thinking skills. When students engage in high-level activities, they must already possess certain information before they are able to solve problems. Students need basic information—of simple formulas, symbols, rules, and facts. Without it, they lack the tool that provides a frame of reference from which to learn new information.

Aside from assuring that all thinking skills are taught, it is critical that these skills be taught in a way that enables students to progress from one level to another. Thus, teachers should begin by introducing the fundamental skills of recall and comprehension, then progress to simple versions of analysis and evaluation, to additional analytical skills of judgment and decision-making, to reinforcing and practicing earlier skills, and finally to integrating critical thinking into the whole curriculum. (Illinois State Board of Education)

Testing

Because traditional paper and pencil tests fail to measure certain behaviors as students go about the process of solving problems, a variety of questioning and observational methods must be used to evaluate students. Methods could include techniques that measure the observable outcomes of thinking skills, or standard multiple choice items that test logical, analogical, verbal, qualitative, and quantitative reasoning. Bloom's taxonomy may be useful in designing test items that assess the different cognitive levels taught. Regardless of the methods used to assess students, assessment should always reflect instruction. *(Champagne)*

Thinking Examples from High School Science

To teach essential elements that require comparing and contrasting, students are given the following activities to demonstrate physical and chemical changes:

Physical changes	Chemical changes
• Dissolving sugar or salt in water	• Heat ammonium chloride crystals
• Melting gold	• Reaction between Copper (II) chloride solution and iron nails
• Freezing water	
• Condensing water	• Burning a magnesium ribbon
• Boiling water	• Burning wood splint or charcoal
• Grinding chalk	• Burning sugar
• Breaking wood	
• Cutting paper	

When confronted with this problem, students first compare it to their relevant background knowledge. They must know the definitions and properties of physical changes and how they differ from chemical changes. They must know the definitions of melting, evaporation, condensation, sublimation, and dissolving; the chemical formula of copper (II) chloride and the symbol of iron; the location of iron to copper on the activity series; and many other factors before they are able to learn new information and solve problems. By applying their knowledge of definitions, properties, symbols and facts to observable changes, they are able to compare and contrast, relate new information to their existing knowledge, explain data, draw inferences, and solve problems.

Students also draw on their knowledge of similar properties in classifying matter into solids, liquids, gases, and plasma; into metals, nonmetals and metalloids; and into mixtures, compounds, and elements. They also demonstrate higher level thought when **inferring** (recognizing material of an object from properties like surface texture, shape, color, odor), **quantifying** (measuring mass, temperature, length, area, and volume in different systems), and **manipulating** (demonstrating experimental procedure; using experimental apparatus, microscopes, voltmeters, and pH-meters; drawing plans, schematics and graphs), and many other skills that make up the science essential elements.

Conclusion

The skills and attributes of the science essential elements are comparable to those that constitute higher level thinking. While research toward defining these skills and attributes continues, science teachers should focus on adopting instructional strategies and testing techniques that target problem solving. Such a methodology, cultivated in an environment that encourages open-minded and unbiased attitudes, would foster scientific and critical thinking in our students.

Teaching the essential elements in science IS *teaching higher level thinking.*

Reference List:

Champagne, A. September 1987. "Definition and Assessment of the Higher-Order Cognitive Skills," National Association for Research in Science Teaching News. 29:3.

Illinois State Board of Education. March 1986. "Skills Essential for Learning." Springfield, Illinois.

Kearney, C. & others. April 1986. "Assessing Higher-Order Thinking Skills." Office of Educational Research and Improvement (ED). Washington, DC.

SOCIAL STUDIES

REALISTIC
EDUCATIONAL
ACHIEVEMENT
CAN
HAPPEN

QUESTIONING STRATEGIES IN SOCIAL STUDIES

Written by
Louis Grigar,
Director of Social Studies

Every teacher has them; every teacher uses them all the time; textbooks are filled with them; tests are built on them; and the nice thing is they are free and always available. What is this thing that permeates teaching? Why it's the question, the stock-in-trade teaching device. Properly phrased and asked, the question is a powerful means for providing opportunities that challenge students to think critically.

What do questions and questioning strategies do for teachers and students? For one, they help teachers to find out what students may already know to determine if they are ready for new learning, and they help students focus on what is important to learn. Questions obviously are vital in determining student progress. Proper questions and questioning strategies can help students master content and provide motivation for further learning.

Unfortunately, studies over the years have shown that many questions are aimed at recalling isolated bits of memorized information at the expense of challenging students to higher levels of thinking. This is confirmed by TEAMS test results, which show that Texas students perform relatively poorly on higher level comprehension skills. Results from various national tests reveal the same weakness. Fortunately for teachers, various teaching models exist to develop student thinking skills. What follows is one such model that focuses on a classification scheme of questions and questioning strategies. This model was developed by Norris Sanders, author of *Classroom Questions: What Kinds?* which is based on Benjamin Bloom's and others' work in the cognitive domain. Though all the examples of questions in this article refer to social studies, the principles apply to a variety of subjects.

Reference List:

Banks, J. 1977. *Teaching Strategies for the Social Studies*, Menlo Park: Addison-Wesley Publishing Company.

Bloom, B. ed. 1956. *Taxonomy of Educational Objectives Cognitive Domain*, New York: David McKay Company.

Carin, A. & Sund, R. 1971. *Developing Questioning Techniques, A Self-Concept Approach*, Columbus: Charles E. Merrill Publishing Company.

Dobkin, W. & others, eds. 1985. *A Handbook for the Teaching of Social Studies*, Boston: Allyn and Bacon, Inc.

Fraenkal, J. 1980. *Helping Students Think and Value, Strategies for Teaching the Social Studies*, Englewood Cliffs: Prentice-Hall, Inc.

Hunkins, F. 1976. *Involving Students in Questioning*, Boston: Allyn and Bacon, Inc.

Morine, H. & Greta. 1973. *Discovery, A Challenge to Teachers*, Englewood Cliffs: Prentice-Hall, Inc.

Sanders, N. 1966. *Classroom Questions, What Kind?*, New York: Harper and Row.

Taba, H. 1967. *Teacher's Handbook for Elementary Social Studies*, Palo Alto: Addison-Wesley.

Before looking at specific examples of questions in various classifications proposed by Sanders, it is important to note the following considerations:

- the term "question" is broadly defined to include student activities, as well as interrogative statements
- the category in which one places a question or activity is directly related to the teaching that preceded it
- emphasis is on the thought processes required
- examples of questions that follow emphasize the development of thinking processes, not attitude or motor skill development
- a number of terms are specialized in their meaning, and
- elements of the preceding levels of thinking are incorporated into the higher levels

What follows are examples of social studies questions illustrative of the various levels of thinking proposed by Sanders. Readers should be aware that:

- questions may vary in complexity in each level
- formats of questions can vary in each category
- subject concepts, generalizations, and principles lend themselves to higher level questions, and
- higher level questions tend to create new learning situations in which students can apply previously learned content

Finally, a background statement is given for each question to illustrate the principle that the level of the question and thought processes required by students is directly related to the teaching that preceded it.

Memory

Memory questions require students to simply recall or recognize information like isolated facts, terms, rules, theories, procedures or skills. This does not mean that memorizing such information is unimportant, for this category is the foundation for higher categories. One does not think without information, but the information must have meaning and importance. All cultures expect its members to know certain meaningful facts; for example, the National Anthem, the first president, and 1776 are illustrative of common knowledge in American society.

Obviously information is easily forgotten unless it is associated with other learning. Memory demands little or no understanding—how many of us really understand the meaning of $E=MC^2$? Memory questions also elicit answers similar or identical to what was learned.

Examples

Background: The teacher presented a lecture on the Constitution with specific reference to enumerated powers.

Question: List the enumerated powers found in the U.S. Constitution.

Background: Students were given a reading assignment in the text on causes of the Great Depression.

Question: What were the causes of the Great Depression?

Background: Students have been studying major battles of the Civil War.

Question: The battle that was the turning point of the Civil War was (a) Antietam (b) Gettysburg (c) the Wilderness (d) Bull Run.

Translation

Translation questions require students to change information into a different symbolic form or language without loss of meaning. In this case the emphasis is on changing in form. The change may be from one verbal form to another; from verbal, to pictorial or graphic form, or may involve matching paraphrased descriptions. Sociodramas are also translation ac-

tivities since they require students to act out ideas.

Examples

Background: A special study group was assigned to collect the Census Bureau's statistics for their city since 1900.

Question: Using the statistics collected on the population of our city, present the information on a bar graph.

Background: Students have studied the concepts of family members as producers and consumers.

Question: Draw two pictures of people in your family as producers and two pictures as consumers.

Background: Students in a government class were assigned to read a section in their text on pressure groups.

Question: Write a summary of the section in the text on pressure groups.

Interpretation

An interpretation question requires students to determine relationships between given parts of a communication (facts, generalizations, definitions, values or skills). Students must recognize relationships that exist. A variety of relationships may be perceived, including cause and effect, and quantitative, comparative, inductive, and deductive relationships. A variety of formats may be used to cause students to see how things are alike or different or the degree of similarity. Students may be asked to compare specific points or to identify irrelevant items. Analogies are also included in the interpretation category.

Examples

Background: Students have been studying the concepts of producers and consumers.

Question: Your mother is a producer when she (a) bakes bread (b) eats bread (c) makes a dress (d) buys a dress.

Background: Students have been studying the major battles of World War II.

Question: Arrange the following events in the proper chronological order by writing the appropriate number before each with (1) being the first event.

_____ Pearl Harbor
_____ D-Day Normandy Invasion
_____ Battle of the Bulge
_____ El Alemain

Background: Students have been studying the characteristics of a capitalistic economic system.

Question: Which one of the following is not an indicator of capitalism:

- profit
- competition
- government ownership of all utilities

Background: Students have studied economic wants and needs, as well as the generalization that wants and needs change.

(Oral)

Question: Which of the following show that our wants and needs change? Which do not?

- When father was a boy, he wanted a new scooter. Now he wants a new car.
- When Maria became a third grader, she gave her doll to her younger sister.
- Bill eats the same cereal for breakfast every day.
- When grandmother was young, there were no T.V. sets.

Application

Questions in this category of thinking are similar to interpretation because students must apply ideas, concepts, rules, and skills previously learned to problems new to them. In application questions, however, students must be able to use an idea, without being told, when a situation or a problem demands it. Application calls for students to transfer and apply learning to new situations.

Application questions deal with usable knowledge, emphasize the use of information and skills, deal with whole ideas, and include a minimum of instruction or directions.

Examples

Background: Students have studied basic economic concepts including wants and needs, difference between goods and services, and production and consumption.

Question: Underline the item that does not fit with the others.

1. (a) food (b) clothing (c) fun (d) shelter
2. (a) barber (b) baker (c) waitress (d) doctor
3. (a) drinking milk (b) milking cows (c) making butter (d) putting milk in bottles

Background: Students in a government class have studied the concept of "strong" vs "weak" presidential administrations.

Question: Which used a different concept of the presidency than the others? (a) Andrew Jackson (b) Abraham Lincoln (c) William Howard Taft (d) Woodrow Wilson

Background: Students have completed a study of the presidential election system, including an in-depth study of the electoral college and constitutional rules governing presidential elections.

Question: The state of Chaos has three representatives in the U.S. House of Representatives. In a presidential election, Chaos voters cast 6,000 popular votes for candidate A and 4,000 votes for candidate B.

A. 0 B. 1 C. 2 D. 3 E. 4 F. 5 G. 6 H. 7 I. 8 J. 9 K. 10

_____ 1. How many electors does the state of Chaos have in the Electoral College?
_____ 2. How many electoral votes does candidate A win in the state?
_____ 3. How many electoral votes does candidate B win in the state?
_____ 4. If no presidential candidate has a majority in the Electoral College, how many votes would Chaos then have in selecting the President?
_____ 5. If no Vice-Presidential candidate has a majority in the Electoral College, how many votes would Chaos then have in selecting the Vice-President?

Analysis

Analysis questions require students to solve problems using knowledge of the parts and forms of reasoning. Students must know when such reasoning is applicable, what rules of reasoning are appropriate, and how to determine if the appropriate rules of reasoning are satisfied. This category is seldom used or is misused because many educators have little or no knowledge of the various processes and rules of reasoning. The processes include inductive and deductive thinking, and knowledge of fallacies, semantics, propaganda techniques, and logic. To utilize this category more, teachers and students should study the forms and rules for reasoning and practice them frequently.

Examples

Background: Students in an advanced Social Science Problems Class have been studying various rules and processes of reasoning.

Question: Critique the following statement: "A recent national survey estimates the number of dangerous drug users among the college population to be five percent. Most of them are concentrated at the 'elite' colleges, so this would mean 350,000 out of seven million students are users of dangerous drugs."

Background: A government class is following a city council debate on allowing builders to build in an environmentally sensitive area. A student brought a letter-to-the-editor item to class.

Question: Comment critically on the following: "If the city council permits Mr. _____ to develop this land now, he will be able to construct houses or duplexes so close to the springs that this wonderful natural resource will be endangered."

Background: The following statements were distributed by a group supporting a public utilities commission to regulate utility rates.

Question: Comment critically on the validity of each of the following statements:

- A system of regulating local telephone service through city government is highly expensive and, except in a few large cities, is totally ineffective.
- Over the past five years the profits of the telephone company have never ranked lower than fifth in all 50 states where the company operates.
- Only one of 11 electric companies had profits below the national average.
- The electric company promotes waste of energy by charging lower rates to consumers who use large amounts of power.

Synthesis

Synthesis questions require a student or groups of students to create an original product like a unique communication, plan, product, or abstract relationship. Synthesis encourages divergent as opposed to convergent thinking. The latter calls for "correct" answers, while the former encourages originality of thought and is less concerned with "right" and "wrong." The key is that the "answer" is new to the student.

Examples

Background: A sociology class has been studying value systems of different world cultures. One member of the class lived in India for several years with her parents.

Question: [For the student who lived in India] Devise a series of episodes to be enacted by members of the class that will show differences in manners, dress, work, and marriage. Follow each enactment with questions that will develop a rationale for explaining the culture pattern.

Background: Students in an economics class have studied various taxes and followed the state's dilemma on raising finances.

Question: Devise a new tax structure to meet the needs of our state.

Background: An elementary class has studied the concepts of citizenship and responsibilities.

Question: List the ways that show a person is a responsible citizen.

Evaluation

Evaluation questions require students to make a judgment. Such judgments may be made about a product, action, event, situation, or form of communication. Most importantly, however, the student must make not only a judgment but also provide the rationale that led to the judgment, subject to the tests of accuracy, validity, and logical analysis. A simple "yes" or "no" response about whether one agrees to a statement will not suffice.

Examples

Background: Students in a U.S. History class studied U.S. foreign policy during the Vietnam War era.

Question: Who had better proposals on policy for Vietnam: the Hawks or the Doves? Explain.

Background: Texas History students completed a study unit on the period 1820-1860.

Question: Who in your opinion contributed more to the creation of Texas: Sam Houston or Stephen F. Austin? Give reasons for your choice.

Background: Students in an Advanced Placement United States History course have studied the historiography of the Franklin Roosevelt era.

Question: Who was the better historian of the FDR era: Arthur Schlesinger, Jr., or D.W. Brogan? Give reasons that support your conclusion.

Summary

To involve students in their own learning in a meaningful, challenging way is a major goal of teaching. The foregoing model of questioning is a stimulating way for teachers to involve students in developing their thinking abilities. It is a practical, useful tool for teaching and learning. Questions can be simple or complex. They can motivate, challenge, focus, and reinforce student learning but, most importantly, they can be a multidimensional tool for opening new vistas of thinking.

TEAMS SKILLS IN SOCIAL STUDIES

Written by Dorris Ketteman, Social Studies Specialist

Who is responsible for teaching TEAMS skills in the elementary grades? Just reading and mathematics teachers in grades 1, 3, and 5? Of course not. All teachers, in every grade, in every subject, are responsible for teaching basic skills. The entire curriculum is rich in opportunities to stretch thinking and provide creative, meaningful learning experiences. And that's as it should be.

Three skill areas tested by TEAMS particularly lend themselves to social studies content:

- main idea
- detail and sequence
- inference

Since teachers at all grades are involved in teaching these skills, this article will discuss activities for all primary and intermediate students. Suggestions should be adapted to span several grades. So, please adopt and adapt!

Main Idea

Primary Grades

Language experience stories developed by students and teacher provide an excellent opportunity to show that reading is talk written down. As students talk about experiences in or out of the classroom, the teacher models and reinforces printed words by writing them on chart paper or transparencies. The class can decide on a title or topic sentence that expresses the main idea of the experience.

Primary Sample Activity

Students take a walking tour of the school and interview personnel about their jobs. When the class returns, they dictate the details of what they saw to the teacher, then draw a picture of one of the workers. Pictures are placed on the bulletin board along with an experience chart and the caption, "Our School Workers Do Many Things." (main idea) Later, the pictures are made into a book for the library table.

Practicing summarizing or stating a main idea are incorporated as "sponge" activities. While students wait in line for lunch, the teacher simply asks, "What's the one important thing we learned about school workers?" Or, after reading aloud from a library book, students state the main idea of the selection.

Intermediate Grades

Similar exercises and experiences for teaching main idea can be adapted for intermediate students. An extension of this skill is finding the main idea or generalization in one piece of information, then finding common patterns between it and other sources.

Intermediate Sample Activity

- Families: What are the common elements in human and animal families? What is the main purpose of any family?
- Explorers: Find a common motivator. What was the main impetus for explorers to seek new lands?
- Wars: Find the pattern or main idea among several wars. Compare generalizations.

Detail

Primary Grades

Identifying specific details and sequencing events can be a creative experience for primary children. In studying customs, celebrations, and significant individuals, students can search for detailed information on a subject in several books, then prepare a comparison chart. The following activity allows students to look at similar information from different sources. It is a beginning research project that could be done with pairs of students.

Less able readers must be given opportunities to show understanding in an acceptable way.

ABRAHAM LINCOLN

	When was he born?	Where did he live?	What were his contributions?	When did he die?
Book A				
Book B				
Book C				

Primary Sample Activity
Teachers can also pick a site in the community and observe the sequence of construction or change. Perhaps a new wing is being added to the school and would be convenient to watch. Students draw pictures of each stage to illustrate progress and add dates to illustrate the sequence of events. These pictures are made into a book or placed on a timeline.

Timelines can also be used to illustrate major points in a child's life. Working with the calendar and using terms like "yesterday," "today," and "tomorrow," provide practice in sequencing and understanding concepts of time.

Inference

Primary Grades
Predicting probable future outcomes is easily taught with the topics of responsibilities, rules and laws, and economics. Consider the following:

Primary Sample Activities

- Play a game called, "What would happen if. . . ." (inference) Set up short stories on the topics of rules and responsibilities, such as: The crosswalk and stop light by the school is a safe place to walk. Cars may not stop for pedestrians at any other place. What would happen if Bobby doesn't use the crosswalk?

Katy's Timeline

Born	Walked	First Word	Preschool	Kindergarten	First Grade
1980	1981	1982	1984	1985	1986

Intermediate Sample Activity
Designing comic strips can motivate students to incorporate details and sequencing. After studying a significant historical event in the community, state, nation, or world, students illustrate their understanding of the event in sequential order. They are also given practice in creative thinking and summarizing important facts. This project can be assigned to all students for practice and to evaluate learning in a form other than an objective test. Less able readers must be given opportunities to show understanding in an acceptable way.

- Use fairy tale stories like *Peter Rabbit* and discuss what happened when Peter did not listen to his mother. What would have happened had he followed his mother's directions?

- Discuss the concept that all people need food, clothing, and shelter to live. Talk about what would happen if there were not enough of each.

Intermediate Grades
Inferences taught in the intermediate grades require students to master

three objectives: (1) identify a reasonable conclusion, (2) distinguish between fact and opinion, and (3) identify a cause and effect relationship. Consider the following:

Intermediate Sample Activities

- Use the social studies textbook, supplementary materials, and newspaper articles to select paragraphs related to a social studies topic. Have students make generalizations and draw conclusions from the details in the paragraph. Make up a title or phrase for the paragraph.
- Drawing on the same paragraphs from above, have students determine if the statements are factor opinion. Look for words like "think," "feel," or "believe," which are clues to opinion statements.
- Prepare short television newscasts reporting an event in the school, community, state, or world. Have student reporters exaggerate the use of opinion statements. Have others simply report the facts. Discuss the difference between fact and opinion in a debriefing session.
- Discuss examples of specialization and division of labor in the school cafeteria, grocery store, or local factory. If possible, observe workers doing specific jobs. Talk about what happens when individuals do not do their job well. Discuss how individual actions affect the entire operation.

Conclusion

When students have the opportunity to learn and practice TEAMS skills in a meaningful context, their chances of mastering these skills are much greater. Take advantage of every opportunity to build skills this way—everyday!

Reference List:

Crutchfield, M. 1978. *Elementary Social Studies, an Interdisciplinary Approach*, Charles E. Merrill Publishing Company.

Hunkins, F. Jeter, J. & others. 1982. *Social Studies in the Elementary School*, Charles E. Merrill Publishing Company.

Marzano, R. & Arredondo, D. 1986. *Tactics for Thinking*, Mid-Continent Regional Education Laboratory.

TEACHING THINKING IN SECONDARY SOCIAL STUDIES

Written by
Elvin Tyrone,
Social Studies Specialist

Secondary social studies courses, if structured to foster thinking and reasoning skills, should provide experiences that help students apply their ideas critically and creatively to historic, economic, geographic, and political events. The social studies teacher's use of subject matter and related activities in the classroom provides the vehicle for students to learn and use a variety of thinking and reasoning skills. The thinking skills and processes that social studies students are expected to master in grades 7 to 12 are:

- locate and gather information
- observe detail
- translate information from one medium to another
- organize and express ideas in written form
- distinguish fact from opinion
- analyze information
- draw conclusions
- synthesize information
- develop criteria for making judgments
- use problem-solving skills
- sequence historical data and information
- draw inferences
- perceive cause-and-effect relationships (Social Studies Framework)

The thinking skills students are expected to master in the reading section of TEAMS bear a striking resemblance to these social studies skills. Thus, by fostering thinking skills in secondary courses through classroom activities, social studies teachers become partners with reading and English language arts teachers in increasing the number of students who are able to read and comprehend at acceptable levels. The TEAMS thinking skills objectives that students are

expected to master in grades 7, 9, and 11 are:

- identify the main idea
- use context to understand the meaning of words
- identify specific details
- identify the sequence of events
- draw logical conclusions
- identify the appropriate reference source
- use reference sources to locate information
- distinguish between fact and opinion
- analyze literary selections (TEAMS: Reading Objectives)

The following social studies lesson illustrates strategies that not only develop reasoning and thinking abilities, but also reinforce secondary reading objectives tested by the TEAMS. These objectives will be identified throughout the lesson.

Sample Lesson

The Way People Lived:
Texas 1900-1929

Level: Middle and high school

Suggested courses: Texas History and Geography, grade 7. This lesson can also be adapted to the following high school courses: United States History, Advanced Texas Studies, Advanced Social Studies Problems, and American Culture Studies.

Lesson Overview

Many students accept what they read or hear without analyzing the source. As students analyze information, they will compare and contrast, noting similarities and differences. As students evaluate information, they will draw inferences and reach tentative conclusions that may change as they interpret and synthesize information from a variety of sources.

Objectives: Students will review narrative from a textbook titled, *Texas, The Land and Its People*, to determine the following:

- social groups of Texans from 1900-1929
- economic status of each group during that period
- group stereotypes

Focus: Introduce the lesson with these questions: "Have you ever wondered how people lived during a certain time? How they made a living? Where they lived?" Explain that the students will read narrative describing how several groups of Texans lived from 1900 to 1929. (The narrative is included in this article, starting on page 99.)

Suggested Teaching Activities: For class discussion, ask students to list the following points from the narrative: (1) the different social groups, (2) how each group earned a living, and (3) words that provide clues about lifestyle. Distribute the narrative handout to students and divide them into groups. If there are several problem readers in the class, the teacher could have a student read it to the group as others listen. Recording the narrative for playback in groups is also an option.

- Ask each group to select at least two examples from the narrative to answer the question, "What differences were there in the way Texans lived during that time?"
- Have groups report their findings.
- Record their answers, plus those that surface in the ensuing discussion.

Introduce the next activity by saying, "Now that we have determined differences in the way Texans lived socially and economically during this time, let's explore how valid our hypotheses are about them. We'll do this by critically looking at our source material." Ask students to base their answers to the following questions on the narrative. Each question not only reinforces social studies skills, but draws upon reading objectives tested by TEAMS.

- How many groups are discussed in the narrative? Name and describe them. (objective: identify specific details)
- Which group enjoyed a social life that included attending dances, movies, theaters, and musicals? (objective: identify specific details)
- Which groups enjoyed the most economic benefits? Which groups did not? Why? (objective: draw logical conclusions)
- What made successful workers "successful?" Are other groups identified as "successful?" Give reasons for your answers. (objective: using context to understand the meaning of words)
- From the description of Negro and Mexican Texans, can you identify vocations or jobs they might have had during this time? Any cultural events they might have attended? Is this also true for successful workers? Give reasons for your answers. (objective: draw logical conclusions)
- Can you prove or disprove the following statement from the narrative about successful workers: "Most of these workers had never known such a good life." (objective: distinguish between fact and opinion)
- From the description of the cowmen, lumber worker, and farmer, identify in rank order which groups enjoyed the most economic benefits. Give reasons for your answers. (objectives: identify specific details, and identify the sequence of events)
- Where would you be more successful as a worker: in the piney woods of East Texas or in the city?

Why? (objective: draw logical conclusions)

Explain to students that a "stereotype" is a standardized mental picture that is held in common by members of a group and represents an oversimplified opinion, attitude, or judgment. Stereotypes carry elements of truth and falsehood. Explain that these two characteristics should be used to further examine the narrative.

Checking for Understanding
Ask the following questions about the narrative:

- From the description of the wealthy, can you identify any vocations or jobs they might have had during this period? What, according to the description, did they do during this time? How is the description an example of stereotyping? (objectives: use context to understand the meaning of words, identify specific details, distinguish between fact and opinion, and draw logical conclusions)
- Contrast the homes of Negroes, Mexican Texans, and lumber workers. How were they similar or different? How were they different from or similar to the homes of successful workers and the wealthy? How is this description an example of stereotyping? (objectives: identify specific details using context to understand the meaning of words, distinguish between fact and opinion, and draw logical conclusions)
- What differences were there in the way Texans lived from 1900-1929? Why are your answers examples of "stereotyping?" (objectives: identify the main ideas, distinguish between fact and opinion, and draw logical conclusions)

Evaluation and Conclusion of Lesson
After students return to their original groups, their assignment is to suggest ways to correct stereotypes in the narrative. Students research the era and groups mentioned in the narrative, then meet to discuss their research. Each group reports its findings and conclusions to the class. Following discussion, the groups each turn in their version of the narrative, rewritten to correct group stereotyping. (objectives: identify the appropriate reference source, use reference sources to locate information, and analyze literary selections)

Narrative

The Way People Lived
TEXAS 1900 to 1929
What differences were there in the way in which Texans lived?

The Rich People
How did the wealthy people live?

The differences in the way people could afford to live were evident all over Texas. The wealthy built mansions in large cities. Some homes were like old plantation homes with large white columns across the front. Other houses were like Spanish haciendas or Italian villas. Well-dressed people entertained in beautiful clubs or danced the Charleston at Galveston's seaside pavilions. Many people attended theaters and musicals or watched the silent moving pictures that were becoming popular.

The Successful Workers
What type of jobs did the city workers have?

Other Texans were able to build homes with two or three bedrooms, a bathroom, a kitchen, and a living room. They took pride in a new gas stove or a little refrigerator that they paid for monthly at Sears-Roebuck or Montgomery Ward. These neat rows of homes belonged to successful salesmen, clerks, or factory workers. Most of these workers had never

By fostering thinking skills in secondary courses through classroom activities, social studies teachers become partners with reading and English language arts teachers in increasing the number of students who are able to read and comprehend at acceptable levels.

Reference List:

Pearson, J., Proctor, B. & others. 1978. *Texas, The Land and Its People.* 2nd edition, Hendrick-Long Publishing Co., 597-600.

Social Studies Framework, Kindergarten—Grade 12. 1986. Texas Education Agency, CU6 370 11, pp.35 & 42.

TEAMS: Reading Objectives and Measurement Specifications, 1986-1990, GE6 725 08, Grade 7, 1986. *TEAMS: Reading Objectives and Measurement Specifications, 1986-1990,* GE6 725 08, Grade 9, 1986. *TEAMS: English Language Arts: Reading Objectives and Measurement Specifications, 1986-1990,* Exit Level, 1985.

known such a good life. The white city worker could even look forward to owning a car if he saved his money.

The Negroes
What were the homes of most Negroes like?

Negroes, however, lived in separate neighborhoods from whites. Most houses in black neighborhoods were small, unpainted shacks. The shacks had no indoor bathrooms or running water. Families still bathed in washtubs.

The Mexican Texans
In what type homes did Mexican Texans live?

In San Antonio, wealthy Mexican Texans lived in the big-house districts. A large part of San Antonio and many of the towns in South Texas still looked like the poorer sections of Mexico City. The plastered houses were close to the streets. They had flowers and shade trees in the yards, but most of the houses had no running water and no bathrooms. The people were very poor and had trouble earning enough money to buy food.

Cowmen, Lumber Workers, and Farmers
How did others live?

Cowboys lived in long bunkhouses on ranches in South Texas and West Texas. They were well fed, even if they did not have much money. Negro and white lumber workers lived in the piney woods of East Texas. The workers' houses were whitewashed or unpainted, with no window panes. The houses, which stood on split-log foundations, were heated by fireplaces and lighted by kerosene lamps. The Texas farmers were not much better off. Most Negroes and many whites did not own the farms they worked. They paid rent for the land or gave the landowner part of the crop. Families trying to make a living as sharecroppers on these red dirt farms often went hungry.

Texas, The Land and Its People, 2nd edition, Jim B. Pearson and others, Hendrick-Long Publishing Co., 1978, pages 597-600.

Secondary social studies courses should provide experiences that help students apply their ideas critically and creatively to historic, economic, geographic, and political events.

THINK CITIZENSHIP!

Written by
Dorris Ketteman,
Social Studies Specialist,

How do we equip our youth to think as citizens; to appreciate the rewards—and responsibilities—of citizenship? The obvious answer is through the knowledge, attitudes, values, and skills that are taught in the social studies program. But social studies is also the perfect vehicle for giving students opportunities to make decisions, solve problems, think creatively, and practice interpersonal skills. These skills play as important a part in developing effective citizens as they do in developing the whole child. Yet, many of these skills are perhaps better "caught," rather than taught, through the models and examples presented in the school community.

The School as a Model Community

Outside the family, school provides the first setting for students to practice citizenship behaviors. Richard Remy says that for students to become competent citizens, they must actually experience making decisions and being responsible. His research shows these experiences must:

- offer opportunities for students to talk about or analyze experiences through group discussion, written or oral reports, or other ways
- be meaningful and interesting to the group
- provide reinforcement and practice without boring repetition
- encourage active learning related to a citizenship competency

What kinds of experiences should students have that prepare them for meeting life's daily demands, as well as for their role as responsible adult citizens? Remy suggests that these experiences should be planned to make children competent in:

- Acquiring and using information
- Assessing involvement
- Making decisions

Through meaningful experiences, vicarious or real, students must be given opportunities to practice thinking through situations—the heart of being a thoughtful, active, participating member of society.

- Making judgments
- Communicating
- Cooperating
- Promoting interests

These competencies provide an excellent framework for a school to use in planning experiences that build responsible behavior in future citizens. The following explanations and examples may help develop the framework.

Acquiring and Using Information

Students examine books, newspapers, magazines, and other media, obtain information from fellow citizens, then apply analysis and evaluation skills.

Schoolwide celebrations of holidays and notable figures create a sense of patriotism and heritage that goes beyond memorizing the birthdate of George Washington or Abraham Lincoln to understanding and evaluating their contributions. Assemblies also give students practice in good audience participation skills and involve parents in planning and production. Schoolwide celebrations can include the following:

- Plan social studies units to research and analyze the characteristics and qualities of a good leader and how the celebrated person exemplified heroism, courage, and conviction in life. Compare present day leaders to past leaders using newspapers, magazines, biographies, and other sources.
- Have students research, write, and act out a scene portraying a time or event in a significant person's life. Use timelines to reinforce time concepts.
- Research the life of the person for whom the school was named. If appropriate, have the person or family members come to an assembly or class and share stories about the person's life.
- Have students discuss the meaning of the words in the National Anthem and Pledge of Allegiance. Research their origins. Present information about the flag and what is symbolizes. Demonstrate proper procedure for handling it. Organize a flag ceremony and have a student, band director, or parent, play "Call to the Colors" on a trumpet. Invite a color guard to the assembly.

Assessing Involvement

Students identify how their actions and beliefs produce consequences in a situation. They also identify their rights and responsibilities as a group and as individuals.

- Within a classroom, an excellent opportunity to discuss responsibility and the positive traits of friendship can be organized through a greeting team. When a new student enters the class, or if a student needs extra academic or social support, a special team or individual student can be assigned to encourage and help their fellow student. Discuss how positive action influences a situation.
- Intermediate students practice responsible citizenship by participating in safety patrol or enforcing safety rules. They can also give helpful information to younger students, serve as tour guides for visitors, or assist in other school projects.

Making Decisions

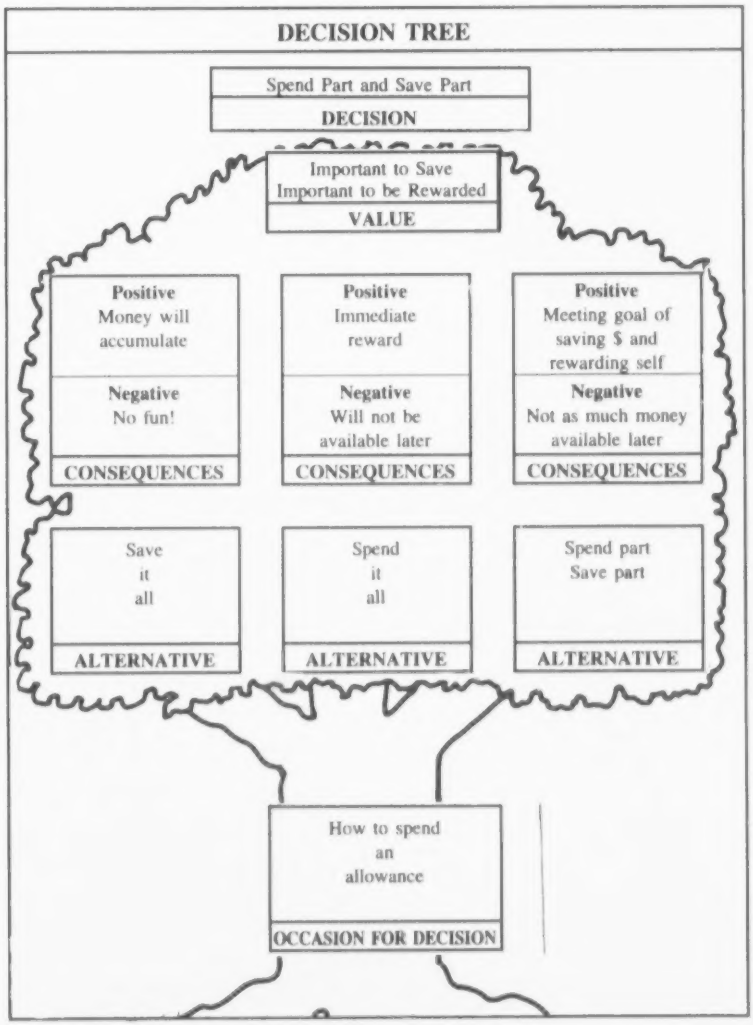
Students practice identifying alternative solutions to problems and their consequences. They also consider goals or values involved in making decisions.

Making decisions and solving problems are important lifetime skills. When students understand that there are not always easy, clear-cut solutions to problems or answers to questions, they begin to realize the dilemmas faced in childhood, as well as adulthood. The rich materials provided in

biographies of heroes and heroines are excellent sources for students to learn about the failures and successes they might face later in life. Through meaningful experiences, vicarious or real, students must be given opportunities to practice thinking through situations—the heart of being a thoughtful, active, participating member of society.

- Reviewing the Day's Decision Making—At the end of the day, set aside a time for review. Ask students to list 10 decisions they made for themselves that day and 10 which others made for them. Rank them in order of importance, then discuss the factors they considered in making each decision and the importance each held for them.

- The Decision Tree—Richard Remy's book, *Citizenship Decision-Making*, offers a powerful model* for students to use in a variety of situations. This model provides a practical approach for students to examine instances where decisions are not clear-cut. The occasion for a decision could be anything from deciding how to spend money or whether to disobey a rule. Alternatives can be brainstormed and possible positive and negative consequences explored. The final decision reflects group values.



*Adapted from *Citizen Decision-Making* by Richard Remy.

Making Judgments

Students identify or develop appropriate criteria or standards for making a judgment, apply criteria to known facts, periodically reassess the criteria, and recognize that others may apply different criteria to a problem.

- Case Studies, Stories, Fables, Fairy Tales—Fictitious, literary characters provide a nonthreatening avenue for teaching students about making decisions and judgments. "The Little Red Hen," for example, provides a study of how the character resolves a dilemma.

Stories and case studies are used in *Character Education Curriculum* to address the issues of courage and convictions; generosity, kindness, and helpfulness; honor; justice and tolerance; use of time and talents; freedom of speech; the right to be an individual; and the right to equal opportunity and economic security. Produced by the American Institute for Character Education, this program has been highly successful throughout the United States.

Communicating

Students present their viewpoint to friends and public officials, or in public meetings.

- Applying for a Position—Rather than simply awarding classroom jobs to those students who raise their hands, or just assigning tasks on a rotating order, students apply for positions. Applying does not need to be complicated; name, age, grade, and a picture of the job desired for first-grade applicants; third-grade applicants might write a description of the job they'd like and their reasons for wanting it; sixth graders can add their qualifi-

cations and plans for handling the job successfully. The process may be oral or written. The procedure helps students feel a greater responsibility toward their jobs and the job selection process.

- Modeling the Election Process—George Washington or an equivalent person is introduced to the class as a leader. After the teacher reads a book about Washington to the class, students brainstorm: (1) the qualities that made Washington a good leader, and (2) categories of public offices. Students bring their favorite stuffed animal to class to run as a candidate. Following a discussion of how ideas influence voting, students write speeches for their candidate and then elect new officers. A public official may be invited to talk to the class about the step-by-step campaign process. To follow up, students create a chart showing the steps involved in running for public office.

Cooperating

Students present ideas about group tasks or issues, take various roles in a group, manage disagreement within a group, and interact with others using democratic principles.

- When students plan, organize, and produce a group project, they practice the skills that are necessary for working successfully with groups and observe the benefits of pooling talents. Students might plan, draw, and paint a mural, while others prepare an oral report that explains the mural. If this is a first-time effort, the teacher would give careful instructions and perhaps role play different situations that might arise in working together.

Promoting Interest

Students identify their own personal interests in a situation and different strategies to exert their influence, work through organized groups to support their interests, understand their legal rights in protecting their interests, and identify grievance procedures within a bureaucracy.

- Students could identify problems in the school that directly affect them. By researching the school rules, students might discover policies that are not being enforced. For example, older students may be taking advantage of younger students on the playground or in the hallways. Strategies could be developed to improve the situation. Posters could be made to communicate the problem and the solution.

Conclusion

The careful blending of knowledge, attitudes, values, and skills are every teacher's challenge—everyday. By teaching and modeling effective citizenship behaviors, we hope our students will automatically THINK CITIZENSHIP!

Reference List:

American Institute for Character Education. 1985. *Character Education Curriculum*, San Antonio, TX.

Colorado Department of Education. 1987. *The Constitution: Experiencing Democracy.*

LaRaus, R. & Remy, R. 1978. *Citizenship Decision-Making*, Addison-Wesley.

Remy, R. 1980. *Handbook of Basic Citizenship Competencies*, ASCD.

MORE THOUGHTS

REALISTIC
EDUCATIONAL
ACHIEVEMENT
CAN
HAPPEN

THINKING IN ADVANCED LANGUAGE HONORS COURSES: A MODEL

Written by
Ines Garcia,
Language Specialist

Instruction in the early stages of language learning gives students the tools for effective communication, concentrating on the lower level thinking skills of knowledge and comprehension. In the advanced language honors courses (after Level III in modern languages or after Level II in classical languages), teachers have both the opportunity and obligation to stress the development of the higher order thinking skills: application, analysis, synthesis, and evaluation. Such an emphasis is appropriate because, in large part, learning the language skills of listening, speaking, reading, and writing is no longer the primary intent of advanced courses. Instead, the content of the subject has become the focus of instruction, and students use higher order thinking to gain a better understanding of it.

The following course description for an Advanced Spanish II Honors course illustrates how a teacher might develop a course to ensure instruction in high-level thinking.

Advanced Spanish II Honors

- **Course Title:** Contemporary Latin America: Social, Political, and Economic Issues
- **District:** Paz ISD
- **Course Description**

A study of six Latin American countries from a sociopolitical point of view, the issues that confront them as they compete in the 20th century, and the prospects they face as they emerge from the third world. This course exceeds the regular advanced language course by stressing a more thorough understanding of the subject content added to the course and by including an independent activity requiring performance in the language. Higher order thinking skills are emphasized as the students master the course content.

...in large part, learning the language skills of listening, speaking, reading, and writing is no longer the primary intent of advanced courses. Instead, subject matter has become the focus of instruction, and students use higher order thinking to gain a better understanding of it.

Reference List:

ACTFL Proficiency Guidelines. 1986. New York: American Council on the Teaching of Foreign Languages.

Modern Languages for Communication (New York State Syllabus). 1987. Albany: The State Education Department.

Omaggio, A. 1984. "The Proficiency-Oriented Classroom," in Theodore V. Higgs, ed., *Teaching for Proficiency, the Organizing Principle*. Lincolnwood, IL: National Textbook Company.

Omaggio, A. 1986. *Teaching Language in Context: Proficiency-Oriented Instruction*. Boston: Heinle & Heinle Publishers, Inc.

Sacco, S. 1987. "Crap Detecting: An Approach to Developing Critical Reading and Thinking Skills in the Foreign Language Curriculum." *Foreign Language Annals*, 20:1, 57-62. Hastings-on Hudson, NY: American Council on the Teaching of Foreign Languages.

Wilkins, D. 1976. *Notional Syllabuses*. London: Oxford University Press.

- **Entry Criteria**
  - Prerequisites: Spanish III with a grade of 90 or above or Advanced Spanish I with a grade of 90 or above
  - Teacher recommendations
- **Materials**

  Basic
  - Lado, Robert. *Tesoro Hispanico*. Webster/McGraw Hill Book Co., 1982.

  Supplementary
  - Hilton, Ronald. *La America Latina de Ayer y de Hoy*. Holt, Rinehart and Winston, 1970.
  - Lewald, H. Ernest. *Latinoamerica: Sus Culturas y Sociedades*. McGraw Hill Book Company, 1973.
- **Instructional Strategies**

  In "Contemporary Latin America: Social, Political, and Economic Issues," the teacher will develop the students' cognitive skills of application, analysis, synthesis, and evaluation with activities such as the following:
  - Using what you know about one of the 20th century presidents of Mexico, write a letter he would write to a family member living abroad. (application)
  - As a member of a panel on Latin American economics, compare the economic status of a relatively stable country like Costa Rica and an economically depressed country like Peru. (analysis)
  - Draft a five-point plan for political stability for one of the countries under study. (synthesis)
  - In a speech prepared for the class, describe persuasively the merits of the five-point plan you developed, explaining its superiority over other alternatives. (evaluation)

The students in the course will be encouraged to engage in creative thinking and problem solving by participating in activities that emphasize fluency, flexibility, originality, and elaboration. The following activities are sample assignments for the course:

- List as many historical consequences as you can for Cuba and the surrounding area, if Castro had not won the revolution. (fluency)
- Categorize the items on the list described above from the standpoint of a Cuban, a Floridian, and a Costa Rican. (flexibility)
- Express your opinion about the future of Mexico by charting a scenario that would take the country through the 21st century, and use Mexico's past as a basis for your ideas. (originality)
- Let us assume that the heads of state of Argentina, Mexico, Cuba, Costa Rica, Peru, and Chile agree to a summit meeting. Provide details about this meeting by choosing a site, an agenda, the issues to be raised and addressed, resource persons to be invited, committees to be formed, and long-term plans. (elaboration)

The teacher will identify the cognitive learning styles of the students by conducting a learning style inventory. The 4 Mat System Model will identify the students as concrete experiential/abstract conceptual or active experimental/reflective observational learners. Students then will choose from activities that may include group projects, simulations, drill and practice, peer teaching, discussion, teaching games, independent study, programmed instruction, or lectures that complement their identified learning style.

Because raising the proficiency level of students is important in a language course, students will be encouraged to interact with others in Spanish as much as possible. They will be asked to identify the native informants from any of the countries studied, plan and conduct an interview with them, transcribe the responses, and draw conclusions from the information.

ADVANCED SPANISH II

Essential Element

Oral communication skills (listening and speaking)
Skills and concepts that result in satisfying routine social demands and limited school or work requirements; culture is taught as an integral part of oral communication skills. The student shall be provided opportunities to:

Regular Course Subelements:

- understand face-to-face speech in a standard dialect on everyday topics
- follow the essential points of a discussion, speech, or explanation on topics in a special field of interest
- comprehend oral language when encountered in a variety of media including radio, television, cinema, and theatre
- express opinions
- describe particular interests and special fields of choice
- participate in casual conversations about current events, work, family, and autobiographical information
- expand the use of fundamental grammatical constructions

Honors Course: Expanded/Added Subelements

- give a short oral presentation on a special topic
- evaluate oral presentations for purpose, organization, and appropriateness of information
- evaluate concepts and devices in oral presentations, for example, logical and emotional appeals and use of metaphoric language
- get into, through, and out of a conversational situation

Essential Element

Written communication skills (reading and writing)
Skills and concepts that result in the ability to read edited textual material or authentic printed material within a familiar context and to write from personal experience social correspondence and compositions on familiar topics; culture is taught as an integral part of written communication skills. The student shall be provided opportunities to:

- identify main idea and supporting details
- read news items describing current events
- understand and write social notes and personal and business letters
- read fiction and nonfiction
- read selections of prose and poetry of moderate difficulty with attention given to style
- write cohesive summaries and short narrative descriptions on factual topics
- express personal preferences and observations in some detail
- understand and use the forms and conventions of written language appropriately
- use reference works such as dictionaries, encyclopedias, and atlases
- expand the use of fundamental grammatical constructions

Honors Course: Expanded/Added Subelements

- evaluate content, organization and topic development of one's own writing as well as that of others

Added Essential Element

Historical developments of Argentina, Cuba, Mexico, Costa Rica, Peru, and Chile

Honors Course: Added Subelement:

- trace major historical events from early beginnings to the present, emphasizing events since World War II
- explore the interaction of these countries with the countries in the East and the West.

THINKING IN THE FINE ARTS

Written by
John Sommer,
Director of
Fine Arts;
Jeanne Rollins,
Art Specialist;
and
Kim Wheetley,
Theatre Arts
Specialist

The true 'basics' of today and tomorrow are thinking skills, such as the ability to analyze and synthesize, to infer accurately, to have in mind problem-solving strategies, to evaluate, to predict, and to be able to communicate effectively through a variety of modes.

Education Commission of the States, 1982

The fine arts can produce a changed environment for learning—an environment in which there are dynamic relationships between students and subject matter in which knowledge and skill become the focus of inquiry and extrapolation. As individuals acquire knowledge, they are empowered to think and reason.

Thinking is the Making of Meaning

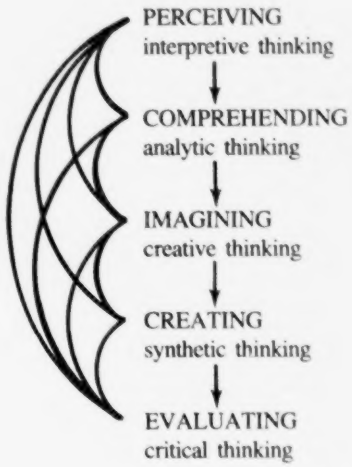
The fine arts capture, create, and communicate meaning. "Over the centuries, human beings have created different kinds of symbol systems to facilitate communication. These include language, numbers, music, two- and three-dimensional visual art, and expression of the body. Often the meaning of one symbol system is untranslatable to another. The symbol systems of the arts possess particular qualities and attributes which communicate meaning in ways in which language and numbers cannot. The function of education in the arts is to equip individuals with the abilities to read (to decipher and synthesize meaning) and to write legibly (to encode and provide a product for an audience) in one or more of the symbol systems of the arts." (Henry Wicke Jr.)

Thinking begins with experience—with sights, sounds, sensations, tastes, and smells. To become better thinkers, students must learn to listen to their own inner voices, to trust their own intuition, and to make their own meaning from each experience. The raw material for creation is all around, available for discovery and use. Images are collected by being sensitive to the physical world. Painters and sculptors find shapes, colors, and textures; musicians find sounds; and actors find characters. One has to open up, focus, and really "see" in order to understand the world and envision new possibilities.

The fine arts curriculum involves the processes of perceiving, comprehending, imagining, creating, and evaluating. These processes provide a focus for the teaching of interpretive, analytic, creative, synthetic, and critical thinking.

artistic processes	types of thinking
perceiving	interpretive
comprehending	analytic
imagining	creative
creating	synthetic
evaluating	critical

These artistic processes and modes of thinking are interactive and often occur simultaneously.



Most thinking takes place in the perception stage. Only very rarely and in very special circumstances is complex logical progression or mathematical processing required. As computers come to take over more and more of our second-stage thinking, the burden will fall even more heavily on the first stage, perception.

Edward de Bono
The Fourth R: Reasoning, *1983*

Perceiving

Our minds influence our perceptions of how we view the world. Part of the process of thinking is directing our senses, and sorting out and interpreting impressions. The fine arts heighten visual, aural, tactile, and kinesthetic perception. The ability to perceive is fundamental to creative expression and aesthetic appreciation. Students learn to see, hear, feel, and comprehend form, space, color, and texture in the environment, thereby enabling them to enjoy, value, and use their sensory faculties.

Attending

Perception begins with attention. Students do not perceive what they do not attend. Learning occurs constantly at both the conscious and unconscious levels. A lesson that is not relevant or challenging, or one that is threatening, will not involve students. It will, in fact, cause their attention to be diverted by other stimuli. Readiness training involves developing students' awareness of when they are or are not attending to a task.

Readiness skills apply to all situations. They include positive thinking and goal setting.

Positive Thinking

The attitudes students have about both themselves and learning affect their ability to accomplish tasks. To achieve a positive frame of mind, students must become aware of and consciously control their attitudes. All thinking is colored with cognitive and affective dimensions. The arts both draw upon and permit the expression of the nuances of feeling that accompany thought.

Sample applications:

all: establishing positive classroom environment, role modeling, conducting personal inventories
art: being receptive to different artists' work (abstract, non-objective, realistic)
music: expanding musical taste through listening and performing
theatre: participating in non-competitive threatre games and trust exercises
dance: being receptitive to different forms of dance

Goal Setting

Setting goals increases the likelihood of task completion and the probability of student success. This requires such metacognitive skills as planning, reflective thinking, and self-monitoring.

Students engaged in art, music, theatre, and dance learn to establish and meet short- and long-term goals both individually and collectively.

Sample applications:

art: expanding skills and concepts for designing, drawing, evaluating
music: developing concepts and skills for listening, performing, evaluating
theatre: refining concepts and skills for acting, stagecraft, theatre production, theatre appreciation
dance: increasing physiologically sound technical skills for more complex movement combinations

Concentration

We are constantly bombarded with a variety of stimuli—sensations, thoughts, and emotions—only a few of which can be processed at one time. Raising or lowering energy levels, bracketing or consciously putting aside unrelated thoughts, and heightening interest by finding personal relevance are techniques that can enhance concentration.

Concentration, the deliberate focusing of the mind on a specific task, is one of the basic tools in the arts.

Sample applications:

art: focusing on manipulation of art media
music: focusing on listening for recurring themes
theatre: focusing while acting; audience's willing suspension of disbelief
dance: focusing on form and technique while dancing

Observation

All human beings possess the same basic senses, but people's minds respond in highly individual ways.

The arts challenge students to observe from different points of view altering perspectives, revealing details, making connections, and fostering empathy.

Sample applications:

art: observing and collecting information about objects in natural and man-made environments
music: interpreting music for solo performance
theatre: studying and analyzing environments, people, cause-and-effect relationships
dance: observing the carriage, movement, and style of people

Memory

The retention and purposeful recollection of the past and present can enable students to affect the future. The most common storage and retrieval techniques are imagery (mental pictures, kinesthetic, auditory, and emotional representations) and association.

The arts employ sensory and emotional recall to explore, understand, portray, and reflect concepts, images, and behavior. Memory is most long-lasting when it is meaningful. The arts provide viewpoints and strategies with which to imbue what is learned with personal, meaningful value and importance.

Sample applications:

art: working with a variety of media to know and understand characteristics
music: memorizing music and marching routines
theatre: recalling sensations and emotions for characterization and technical design, memorizing dialogue
dance: remembering kinesthetically

Conceptualization

Concept attainment is more than labeling or developing vocabulary—it is the understanding, organization, and application of ideas.

> Declarative memory contains the who/what/where/when/why facts about the world. Procedural memory contains information about processes. Knowing content, then, is knowing the declarative and procedural knowledge relative to concepts in an academic area. Declarative knowledge requires an understanding of basic concepts and large organizational patterns of information. Initially a child's understanding of a concept can be described as a set of images (mental pictures, kinesthetic, auditory, and emotional representations) with some linguistic description of the concept. This implies that concepts should be first introduced to students at an experiential level. If direct experiences cannot be provided, they should be stimulated through guided imagery (indirect visual, kinesthetic, auditory, and emotional experiences).
> (Marzano and Arrendondo)

Concept formation is faster, deeper, and more likely to occur in different styles of learners when concepts are explored through a variety of media. The arts provide experiences that evoke mental pictures, sensations, and emotions basic for attainment and understanding of specific knowledge and abstract concepts.

Sample applications:

art: understanding and knowing line, form, color, space, texture
music: understanding and knowing timbre, harmony, rhythm, form, dynamics
theatre: understanding and knowing plot, character, thought, diction, music, spectacle
dance: understanding and knowing focus, level, direction, dynamics, dimension, contour

Intuition

Intuition is immediate cognition, based on understanding of universal truths. It provides sharp insight into things that are not readily evident.

The arts develop non-verbal, multi-layered levels of understanding enabling students to make inferences and hypotheses. Reflective thinking is encouraged as they become aware of and rely on their intuition.

Sample applications:

art: spontaneous expression through art media, experimentation with art tools and media
music: improvisation, sight reading
theatre: improvisation, non-directional blocking
dance: spontaneous movement

Emotional Identification

Our perceptions are influenced not only by our mental images, but also by our emotions.

The arts provide insight into how visual, aural, verbal, and spatial symbols express and evoke emotions.

We must live as we think, otherwise we shall end up by thinking as we have lived.

Paul Bourget
Le Demon de Midi, 1914

Sample applications:

art: using art principles to convey or elicit response: studying universality of visual symbolism

music: using contrasts: dynamics, tempo, timbre, rhythm, harmony

theatre: examining character attitudes and behavior, evoking emotions through technical design (scenery, costumes, light, sound)

dance: expressing emotion in qualities of movement (sustained, percussive, swinging, suspended collapsing, vibratory)

Comprehending

In processing and storing incoming information, one categorizes, matches, compares, and patterns new information in relation to what is already known. By making generalizations and analyzing similar and dissimilar characteristics, a person is able to make connections and render the unfamiliar familiar.

As a mirror of the human condition, the arts promote recognition and identification and inspire reflection.

Analysis

Even as we perceive the world, our minds are sorting information and relating it to what we already know. Analysis, one of the most common thinking processes, involves breaking down complex concepts into smaller, more manageable parts in order to perceive and understand existing relationships.

Artists constantly analyze, decide, reexamine, and appreciate. Based on analysis, the creative understanding and manipulation of artistic elements yield new expressions of meaning.

Sample applications:

art: analyzing art works of major artists and self

music: determining causation (blend, balance, intonation, precision)

theatre: analyzing scripts for directorial concepts, characterization, and technical design

dance: analyzing dance techniques (ballet, modern, jazz, tap, folk, character)

Comparison

Metaphorical and analogical thinking clarify meaning by drawing parallels and making abstract comparisons. By using metaphors to compare unlike things and analogies to point out similarities between unlike things, one is able to make new connections and change perspectives.

Comprehending the descriptive, derivative, and interpretive spectrum of the arts requires the ability to compare and contrast.

Sample applications:

art: comparing art works within distinct periods

music: comparing music from different periods

theatre: comparing plays and production styles from different periods, comparing characters (voice, movement, attitude, action); comparing reality and theatrical representation

dance: comparing dance styles from different periods

Pattern Recognition

Comprehending large quantities of information is fostered by organizing patterns of concept, likeness, sequence, generalization, and process.

Students in the arts learn to recognize, adapt, and invent stylistic, thematic, structural, developmental, and procedural patterns.

Sample applications:

art: recognizing patterns, forms, and style of artists' work

music: recognizing and performing rhythmic and melodic modes

theatre: recognizing patterns in voice (characterization, dialects), movement (mimetic gestures, period styles), dramatic structure, playwrights' treatment of recurrent themes, historic production styles (acting, directing, technical)

dance: recognizing patterns in routines

Extrapolation

Extrapolation encourages divergent thinking by establishing relationships between seemingly unrelated concepts. It is the process of matching patterns of information in different contexts or from different areas.

The arts juxtapose reality and representation, past and present, colors, textures, tones, tempos, emotions, and movements.

Sample applications

art: relating structure found in nature to design characteristics (repetition, emphasis, movement)

music: studying characteristics of music and architecture during various historical periods

theatre: applying observations of people, animals, and objects to characterization, applying acting and technical theatre skills in daily life; recreating dramatic themes or plots in different settings and time periods

dance: depicting ideas and themes through movement

Imagining

Through imagination we can challenge the limits of knowledge and possibility, speculating about things not only as they are, but as they might be. The ability to imagine is not only of value in and of itself but has been linked to cognitive processes like problem solving and metacognitive processes like self-direction.

Inference

We often respond to incomplete information by formulating decisions based upon inferred evidence.

The arts imaginatively explore and expand basic information and concepts through elaboration and improvisation.

Sample applications:

art: elaborating on a theme through a series of art works

music: performing jazz improvisations, theme and variations

theatre: staging a playscript (subtext, characterization, direction, technical design), improvising scenes, coping with unexpected occurrences during rehearsal and performance

dance: improvisationally exploring movement concepts and problems

Without imagination, thought comes to a halt.

Wilferd Peterson
The Art of Living, *1977*

The brain is not just a dealer in information; rather it is like an artist, a creator of experience for itself and for others. Thought in the broadest sense is the creation of worlds, both 'real' and imaginary.

Frank Smith
Essays into Literary, *1983.*

Imaging

Imaging is the mental recall of previously perceived pictures, sounds, smells, tastes, tactile, and kinesthetic sensations. The process of imaginative thinking involves associating linguistic symbols with mental images, physical sensations, and emotional responses.

The fine arts nurture internal and external imaginative behavior. Exercises for heightening observation and concentration skills stimulate the formation and retention of a repertoire of images. Solving artistic problems involves the process of imaging as students expand, combine, alter, and transform images. Imagination is eventually externalized through the final creative act or performance.

Sample applications:

art: combining, expanding, and transforming visual images through media
music: interpreting musical compositions
theatre: imagining characterization, visualizing blocking, designing technical elements
dance: transforming time, space, and energy

Creating

All cognitive processes are in essence creative since they involve the active construction of ideas and information. The invention of artistic products includes recognition of a need, desire, or impulse to create something; commitment; establishment of criteria; synthesis; development; refinement; presentation; and evaluation.

Process

The act of creating requires the adoption of procedures that combine past learning with new insights resulting in a new product. Artistic processes include fluency, application, and collaboration.

- **Fluency**
  Basic developmental processes lead to the acquisition of psychomotor skills and the enhancement of mental flexibility.

Sample applications:

art: developing technical skills through art media
music: performing contrasts of high/low, up/down, fast/slow, loud/soft, same/different, long/short
theatre: developing physical and vocal expressive skills and stagecraft skills
dance: developing coordination, flexibility, strength, control, and endurance

- **Application**
  Operational procedures integrate individual psychomotor skills with techniques for manipulating materials and equipment. This allows the individual to make use of these skills in a variety of new contexts, with a variety of new problems, and is sometimes referred to as "transfer of training."

Sample applications:

art: applying technical skills in imaginative expression through art media
music: reading musical notation at sight
theatre: warming up physically and vocally, analyzing a script, auditioning and rehearsing, safely using technical equipment, following a production schedule
dance: applying movement techniques (barre, isolations, axial, locomotor)

- **Collaboration**
  Collaborative thinking requires the development of interpersonal skills so that individual creativity is assimilated into the cooperative group process. Invention and problem solving within a group, so common to work in the arts, improves general learning and achievement, and develops metacognitive skills.

Sample applications:

art:	planning and installing art exhibitions
music:	participating in ensemble rehearsal and performance
theatre:	producing theatre (rehearsals, crews, performances)
dance:	rehearsing and performing dance compositions

Problem Solving

Creative problem solving extends beyond scientific verification to divergent exploration of an array of options leading to decision making.

The fine arts encourage independent and cooperative thinking for inventive problem solving. Following problem identification, students ask probing questions, brainstorm, engage in research, explore alternative solutions, predict outcomes, and make informed decisions and artistic choices.

Sample applications:

art:	limiting art elements, principles, and media to foster creative expression
music:	improving performance via individual adjustment of pitch, volume, tempo
theatre:	improvising, producing theatre (script selection, directoral choices, characterization, technical design and realization)
dance:	composing movement studies based on music and dance forms

Invention

Invention is a systematic way for creating new forms. It includes identifying purpose, commiting to the task, selecting criteria, discovering the unexpected, and developing and refining the product.

The arts value unique expression, encouraging students to explore and experiment.

Sample applications:

art:	expressing individual ideas through drawing, painting, printmaking, sculpture, fibers, ceramics, jewelry
music:	composing music
theatre:	directing plays, writing plays
dance:	improvising movement studies, choreographing dances

Evaluating

As one of the highest levels of thinking, evaluation requires consideration of perceptual reflection, imaginative options, and procedural decisions in order to express and validate intuitive responses.

Involvement in the artistic process and exposure to quality artistic creations and productions provide the comparative basis necessary for the development of discriminating taste. Students learn to recognize, analyze, assess, and value the arts in terms of purpose, context, form, and technique as they apply established criteria and develop personal standards in evaluating work by themselves and others.

In addition, evaluating is related to metacognitive skills like reflective thinking, planning, goal setting, self-monitoring, and selecting cognitive strategies for problem solving.

The purpose of thinking is to arrange the world in our minds so that we can apply values and emotions.

Edward de Bono
Lateral Thinking: Creativity Step by Step, *1970*

Critical Analysis

People analyze and criticize ideas and products basing their appraisal on knowledge and experience. Critical response begins in perception and ends in aesthetic judgment based on standards and criteria that are both cognitive and affective.

Familiarity with artistic theories as well as with historical, personal, and critical writings can stimulate students as their own systems of evaluation evolve. Responses are made in part on the basis of comparison. Understanding each art form and the interplay of the arts on one another and on society contributes to the development of critical acumen.

Sample applications:

art: analyzing art works based upon specific criteria

music: critiquing performances based on benchmarks of excellence

theatre: analyzing scripts, evaluating the production process, critiquing theatre productions based on evaluative criteria

dance: analyzing works of dance artists

Valuing

The ability to judge the value of what one does and experiences is the essence of critical thinking and the opposite of passive acceptance and unthinking rejection.

Assessment of artistic experiences encourages students to go beyond initial emotional responses and personal preferences. Through experience and knowledge, students come to understand and appreciate the creative efforts of themselves and others.

Sample applications:

art: exhibiting appreciation of a variety of art works

music: appraising musical concepts and performance

theatre: developing appreciation of a variety of theatrical experiences

dance: appreciating dance as presented in concerts and theatre

Conclusion

Perceiving, comprehending, imagining, creating, and evaluating are basic to higher-level thinking. These artistic processes enable students to:

- visualize, identify, and analyze what IS
- integrate ideas, synthesize combinations, generate options, and imagine what COULD BE
- consider constraints, assumptions, and consequences to determine what SHOULD BE

Thinking in art, music, theatre, and dance captures, creates, and communicates meaning.

Reference List:

Arnheim, R. 1969. *Visual Thinking*. Berkeley: University of California Press.

Gardner, H. 1983. *Frames of Mind*. New York: Basic Books Inc.

Kirby, D., Kuykendall, C. & others. 1985. *Thinking Through Language*. Urbana, IL: National Council of Teachers of English.

Marzano, R. & Arrendondo, D. May 1986. "Restructuring schools through the teaching of thinking skills," *Educational Leadership*, Alexandria, VA: Association for Supervision and Curriculum Development.

Marzano, R. & Arrendondo, D. 1986. *Tactics for Thinking*. Mid-continent Regional Educational Laboratory, Aurora, CO.

Nummela, R. & Rosengren, T. May 1986. "What's happening in students' brains may redefine teaching," *Educational Leadership*, Alexandria, VA: Association for Supervision and Curriculum Development.

Sternberg, R. 1985. "Critical thinking: its nature, measurement, and improvement," in Essays on the Intellect, ed. Frances Link, Alexandria, VA: Association for Supervision and Curriculum Development.

Wales, C., Nardi, A. & others. May 1986. "Decision making: new paradigm for education," *Educational Leadership*, Alexandria, VA: Association for Supervision and Curriculum Development.

Wicke, H., Jr. February 1982. "A rationale for the arts in education," *Theatre News*.

HELPING YOUNG CHILDREN THINK

Written by
Amie Beckett,
Prekindergarten
and
Kindergarten
Specialist

We are blessed with the capacity to know about, make sense of, and to some extent, control our world. By learning to apply higher level thinking to new situations, we can channel our curiosity and develop control over the learning process. Higher level thinking refers to any type of thinking beyond recall. It allows us to classify new information into categories, infer relationships between categories, develop hypotheses about the solutions to problems, and evaluate their effectiveness. Higher level thinking provides the medium for generating ideas and processing information; thus, it is an essential function of cognitive growth.

Two guidelines exist for developing higher level thinking at any level in the school curriculum:

- Consider higher level thinking as an essential component of the total school program. It will not be effective if used solely as enrichment.
- Permeate the curriculum with activities that require students to think, rather than approaching thinking as an isolated "skill." Higher level thinking is a process that should be practiced in every school activity; it is not tied to a particular subject.

The major intellectual function of early childhood and the key to higher level thinking in preschool is the development of concepts that allow children to deal with a world of new experiences. If children recognize the characteristics of a dog (for example, four legs, fur-covered body, makes a barking sound), then they are more likely to recognize that a poodle and a dalmation are similar. Concept development allows children to transfer knowledge to new situations, and to organize and classify new information.

Preschoolers have educational needs that influence the degree and kind of knowledge they gain from new experiences. Since they lack experience, they learn through active manipulation and sensory information. Children gain new information through sight, sound, feel, smell, and taste. Real objects and experiences provide the sensory information young children need to integrate new information into existing frameworks.

Preschoolers are unable to infer meaning from symbols. They may be able to recognize the symbol for the letter A, but that does not necessarily mean they also understand that A is a fragment of another word, that it can be combined with other fragments to form different words, and that those words have meaning in the context of writing. Even if preschool children can reorganize the written representation of the word "in," they may not understand the meaning of "in danger," "in December," "in the city," or "in love." These are concepts young children learn through real experiences. The concept of "city," for example, is developed with experiences or associations with tall buildings, many people, traffic congestion, or movement and activity. The richer the experiences related to a concept, the deeper the understanding of how to use that concept to solve problems and make predictions.

Play is the vehicle for integrating new concepts. Through play, children practice concepts and apply them to new situations. For example, when in the dramatic play area, children might withdraw their fingers quickly from a toy iron because it is "hot." The assignment of roles in dramatic play ("You be the mama and I'll be the spaceman.") allows children to develop characters and plots that increase listening comprehension.

If children are to learn to read, write, spell, and compute with proficiency, then the answer is not to give them more basal readers and traditional instruction. The answer is to provide them with the time and opportunities to play.

Carl Glickman
Problem: Declining Achievement Scores, 1979

Studies show that the people most capable of creative problem solving are those who had a rich variety of experiences with supportive adults during their early years. The concert pianists, Olympic swimmers, research scientists, and mathematicians recently studied by Benjamin Bloom all recalled a broad range of activities as young children. They experimented with their areas of later specialization in play situations. Their parents and teachers were enthusiastic about the children's experiments and encouraged them to play and have fun with new material.

This early play stage was essential to developing the basic concepts and motivation to continue learning. One concert pianist who missed this early play stage, was motivated to play only after he had a chance to broaden his musical knowledge with extensive listening activities. He developed a passion for classical music and the desire to play the pieces he loved. Although his early efforts at playing the piano were poor, his teacher had the vision to encourage him despite his lack of skill. The lesson behind the story is clear: Preschool educators are wise to let children practice higher level thinking through play experiences to encourage curiosity and independent learning.

Play behaviors follow a developmental progression that corresponds to the levels of cognitive growth. Passage from one stage to the next is dependent upon increased independence from real objects. At the beginning stages of imaginative play, children must have an object to determine the direction of play. With maturation and practice, they gradually acquire the ability to sustain dramatic practice without objects, although they may still use them. In the final stage of play, children control their choice of objects.

Characteristics of the major stages of play include:

Stage 1: At the earliest level of symbolic play, children are dependent upon objects. The use of an object may be pantomimed—a spoon might be used to eat an imaginary bowl of soup, for example. Although one object may sometimes be used to represent another—a banana might be used as a phone receiver—the function of the object is usually pantomimed using the actual object.

Stage 2: Two objects can be used in pantomime, but one must be used according to its typical function. Grass may be used to represent cat food for a toy cat, for example. In this case, the function of the toy cat is similar to that of a real cat, but the use of grass for cat food is atypical.

Stage 3: Children are able to dispense with objects altogether, if they wish. At the same time, they are able to develop characters and plots during play. Instead of simply pretending to wash the dishes, they are able to play the roles of father, sister, and other characters in the play segment. This stage involves a greater degree of higher level thinking. The level and degree of elaboration in the development of plot and character, and the language used during play, reflect the children's depth of understanding about roles and situations.

Stage 4: Children begin to elaborate upon themes in dramatic play that are not a direct reflection of their experience. Well-developed fantasy themes are possible because children at this stage are capable of more symbolic play.

Critical skills related to imaginative play include:

- listening
- relating and discussing personal experiences

- retelling stories, including sequencing
- pantomiming limited themes
- using oral language in a variety of situations
- practicing gestures and facial expressions to convey emotion
- distinguishing between real and make-believe in stories
- becoming acquainted with a variety of selections, characters, and themes in our literary heritage.

The level of imaginative play is dependent upon the quality of children's experiences. In a study by Shirley Brice Heath, successful students' learning experiences at home were found to be similar to those at school. These children played with educational materials, had books, and were read to regularly. Parents welcomed questions from their children and encouraged discussion and evaluation of their experiences.

Because of their broad experience, these students were able to fill class time with self-directed activities that represented an elaboration and integration of the concepts they learned in formal lessons. In a play sequence described by Genishi and Dyson, two children, ages 5 and 7, created a space fantasy using a model spaceship they had built earlier. Conversation included references to military ranks, reports, and specific places. The children were familiar with a variety of topics, and their language was specific, including such terms as "damage," "headquarters," "lounging," and "third." They were able to transfer their knowledge about those concepts to a play situation.

Less successful students had limited opportunities to learn through activity; instead, they were encouraged to participate passively. Their experiences were not as numerous as those of other children, and they were likely to take place in limited social contexts. Adults in their lives did not communicate regularly about their activities, model positive work attitudes, or encourage their children to express themselves. They did not offer learning opportunities through questioning and probing; the level of communication in their homes was superficial.

Because these students lacked an environment that encouraged intellectual exploration, their ability to initiate imaginative play was severely hampered. They did not choose to spend time playing because it was frustrating, and the problem was perpetuated: they failed to gain the practice needed for cognitive growth because they had insufficient opportunity to play. In transcripts collected by Genishi and Dyson, play was centered around common daily activities at home. Language was basic, unspecific, limited, and coupled with physical gesturing. The students expressed little understanding of the concepts that lead to school success.

Studies of individuals who have overcome a disadvantaged childhood and taken greater control of their lives indicate that at least one significant adult in their lives inspired them and provided the incentive they needed to progress. In some cases that person was a teacher who supplied the type of learning environment needed for intellectual growth.

How can teachers help students practice and extend concept learning during play? These four strategies are useful:

Questioning helps students organize and elaborate on play themes. Through questioning, roles are defined, object use is clarified, and characters and sequences of events are elaborated.

Studies show that the people most capable of creative problem solving are those who had a rich variety of experiences with supportive adults during their early years.

Suggestions for questioning:

- Ask who, what, where, when, why, and how questions.
- Question at different levels of difficulty. Challenge students with translation, interpretation, application, analysis, synthesis, and evaluation questions. Example: "What did Papa Bear say when he saw his Baby Bear's broken chair?"

Structuring sets the stage for play. The teacher sets up the environment before students work independently with objects.

Suggestions for structuring play:

- In the dramatic play center, correlate the themes or environments of play to the units being studied. If students are studying community workers, for example, objects may be set up in the play area to simulate a hospital environment.
- Before setting up a new dramatic play area like a grocery store, take a field trip to allow the students to examine roles and use of objects.
- Notify parents about the themes ahead of time so they can give information to their children and send objects.
- Talk to the students as they explore objects. Try to elicit as much language as possible from them to help structure play.
- Involve the students in setting up the play area.

Responding to needs in the early play stages requires teachers to take an active role in helping students develop their play. Cues should be provided to help them expand their language and actions. As they become more independent, students can practice on their own.

Suggestions for responding to needs:

- Maintain an open, non-threatening atmosphere. Imaginative play is not designed to be a "production." Students should be free to experiment and make mistakes.
- Allow plenty of time for play in all centers and encourage their frequent use. This will allow students to explore different characters, situations, and materials.

Modeling is necessary when students have had little prior experience with the theme of play. The play sequence is shaped through teacher modeling.

Suggestions for modeling:

- Have a guest model how to use objects in the play area.
- Role play or demonstrate a play sequence with puppets.
- Accompany the students in role playing.
- Ask for volunteers from the class to model the use of objects and dialogue.

Possible dramatic play themes:

- fire station
- hospital
- office
- airport
- grocery store
- construction site
- trains
- shoe store
- bakery
- service station
- barnyard
- zoo

With careful planning and monitoring, teachers can provide a classroom environment conducive to higher-level thinking. Such an environment is critical to the later success of students who will apply their knowledge about the world in increasingly symbolic ways. By encouraging imaginative play with objects, teachers allow students to direct their own learning and gain additional information for solving problems—a critical skill for lifetime learning.

Reference List:

Bloom, B. ed. 1985. *Developing Talent in Young People*. New York: Ballantine Books.

Genishi, C. and Dyson, A. 1984. *Language Assessment in the Early Years*. Norwood, New Jersey: Ablex

Glickman, C. 1979. *Problem: Declining Achievement Scores. Solution: Let Them Play*. Phi Delta Kappan. 69:6, p.454

Heath, S. 1983. *Ways with Words. New York:* Cambridge University Press.

Johnson, J. & others. 1987. *Play and Early Childhood Development*. Glenview, Illinois: Scott, Foresman and Co.

Moyer, J. & others. 1987. "The Child-Centered Kindergarten." Position paper of the Association for Childhood Education International. *Childhood Education*, 63:4, 235.

Spodek, B. ed. 1982. *Handbook of Research in Early Childhood Education*. New York: The Free Press.

Williamson, P. and Silvern, S. 1986. "Eliciting Creative Dramatic Play: Classroom Procedures." *Childhood Education*, 63:1, 2.

INSTRUCTION AND ASSESSMENT MUST MATCH

Written by
Sally Wiedemann,
Director of Business Education

In the last decade, most states in the nation have either begun to explore or are earnestly debating how to improve thinking and reasoning skills. The interest in improving thinking is well founded, as many leaders in education, business, and industry agree that people with the ability to think and reason effectively will be those who make best use of the information explosion continuing in the 21st century.

Two education researchers, Marzano and Arredondo, believe that the direct teaching of thinking skills within formal education will necessitate a change or restructuring of curriculum, instruction, and assessment techniques. While other recent research identifies the thinking skills that students should know, and the methodology for teaching these skills, little information is found on assessing student proficiency. One point on which most researchers agree is that teachers must assess—and assess at the same thinking level at which they provide instruction. Diagnosis and evaluation are then truly comprehensive.

This article includes information that will enable teachers to recognize, develop, or evaluate questions and tests that assess how well students are learning each level of thinking. Although Socrates was sentenced to drink a fatal cup of hemlock for teaching young Athenians how to think, using some of these tips should be far less unpalatable.

The Purpose of Assessment

In the five steps of the teaching and learning cycle—content analysis, diagnosis, prescription, instruction, evaluation—teachers must assess the performance of each learner to determine the next learning step to be mastered. Checking for understanding could be informal observation or oral answers to questions; testing to determine competence could be formal, written examination.

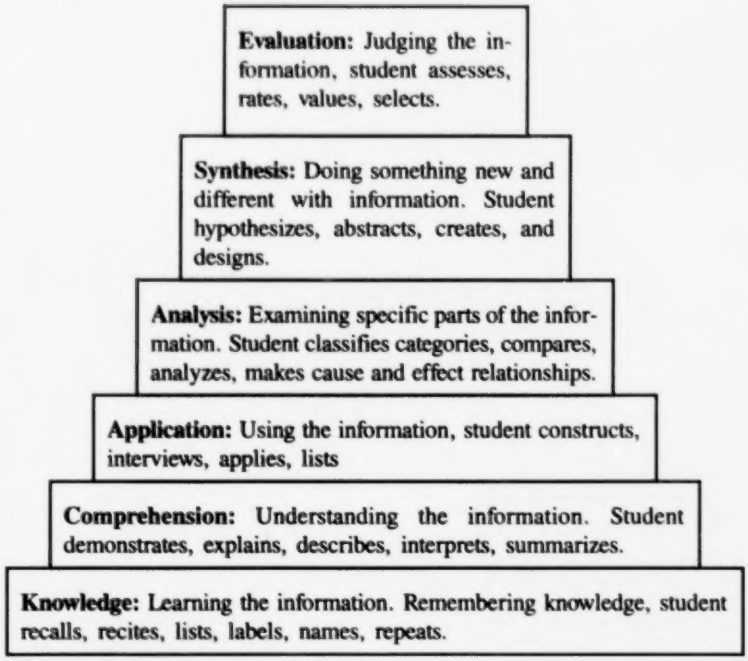
One point on which most researchers agree is that teachers must assess—and assess at the same thinking level at which they provide instruction.

Identifying Levels of Questioning and Testing

Teachers ask questions in all classroom activities—in discussions, written assignments, and tests—and their questions determine the level of thinking students must use to respond. Current research indicates that 80 to 85 percent of all questions asked by teachers are factual and measure recall only. By using *Bloom's Taxonomy of Educational Objectives*, included in this article to provide a common understanding of terms for levels of thinking, it is clear that only the lowest level of thinking is assessed when recall questions are asked. Or, that a higher level is assessed when analysis questions are asked.

Bloom's Taxonomy of Educational Objectives

Highest Level of Cognition


Evaluation: Judging the information, student assesses, rates, values, selects.
Synthesis: Doing something new and different with information. Student hypothesizes, abstracts, creates, and designs.
Analysis: Examining specific parts of the information. Student classifies categories, compares, analyzes, makes cause and effect relationships.
Application: Using the information, student constructs, interviews, applies, lists
Comprehension: Understanding the information. Student demonstrates, explains, describes, interprets, summarizes.
Knowledge: Learning the information. Remembering knowledge, student recalls, recites, lists, labels, names, repeats.

Lowest Level of Cognition

Falkof and Moss compress Bloom's taxonomy into four thinking and questioning levels:

When The Thinking Level is:	The Question is:
evaluation	evaluative
synthesis	creative
application or analysis	interpretive
knowledge or comprehension	factual

Matching Instruction and Assessment

While taxonomies group instructional objectives, the objectives in turn shape the curriculum, direct instruction, and provide guidelines for evaluation. As educators move beyond teaching the acquisition of knowledge, assessment must also move beyond recall. Instruction and assessment should match.

The levels of questions that teachers plan to test should be used in daily instruction, not simply on the test. Thus, if synthesis is to be tested, students should practice synthesis in regular instruction to ensure fair, formal testing. The lower levels of thinking are prerequisites for higher levels, so that when comprehension is tested, knowledge is also tested; when application is tested, knowledge and comprehension are included, too. Ultimately, when evaluation, the highest level of thinking, is assessed, all other levels of thinking—knowledge, comprehension, application, analysis, and synthesis—are automatically assessed.

Classifying Test Items

Classifying test exercises is just as complicated as classifying educational objectives. However, the following chart adapted from CAPTRENDS can be used by teachers as a quick-and-easy way to evaluate questions or tests in instructional materials.

If the question identifies:	The question is testing this thinking level:	Sample Questions:
What students must remember	Recall	What is the electoral college?
What students must restate in other words	Comprehension	How does the electoral college work?
What information is to be used to solve the problem	Application	Predict what would happen if the electoral college were eliminated.
What is broken down into what parts	Analysis	Differentiate the various roles of the electoral college.
What two pieces of information are to be combined	Synthesis	How can the electoral college and the popular vote produce different results?
What students are to express an opinion about	Evaluation	In your opinion, should the electoral college be retained or abolished? Defend your choice.

Current research indicates that 80 to 85 percent of all questions asked by teachers are factual and measure recall only.

The levels of questions that teachers plan to test should be used in daily instruction, not simply on the test.

Key Words for Developing Questions and Tests

The questions that teachers use to guide student participation and develop tests determine how students perceive teacher expectations. The key to designing questions that clearly convey teacher expectations—and clearly measure a specific level of thinking—is to focus on the verb or action word that describes the thinking level. The following chart offers key words for developing questions and tests.

If teachers want to measure:	Begin the questions with these key words:		Sample Questions:
Recall	list	fill in	List the parts of speech.
	describe	identify	
	define	what	
	label	when	
	repeat	who	
	name	where	
Comprehension	paraphrase	translate	Explain what purpose the verb serves in a sentence.
	explain	interpret	
	review	how	
	match	why	
	discuss		
Application	apply	employ	Write a sentence that includes a noun, verb, and direct object.
	construct	restructure	
	draw	predict	
	simulate	how	
	sketch	write	
Analysis	classify	contrast	Break this sentence into components by diagramming it.
	dissect	categorize	
	distinguish	separate	
	differentiate	breakdown	
	compare	subdivide	
Synthesis	combine	integrate	Combine what you know about good sentences and paragraphs to write an essay on...
	relate	assemble	
	put together	collect	
Evaluation	judge	rate	Evaluate this paragraph. Is it good? Why or why not?
	argue	debate	
	assess	evaluate	
	appraise	choose	
	decide	should	
	defend		

Cue Words for Thinking Activities

The following chart is an adaptation of Bloom's taxonomy by Brooks that rephrases or adds words that cue the level of thinking activities.

Level of Thinking:	Cue Words:	
Knowledge ***Recall*** Remembering previously learned material	observe repeat cluster outline record	memorize recount sort match define
Comprehension ***Translate*** Grasping the meaning of material	recognize locate identify restate tell support summarize	report express cite review document describe
Application ***Generalize*** Using learned material in new and concrete situations	select use manipulate sequence organize imitate frame	dramatize illustrate test out/solve apply known show demonstrate
Analysis ***Break Down/Discover*** Breaking material into component parts to be more easily understood	examine compare map question research interpret refute debate	characterize contrast analyze outline infer relate to conclude defend
Synthesis ***Compose*** Putting material together to form a new whole	propose plan compose speculate create invent	construct emulate imagine formulate design
Evaluation ***Judge*** Judging the value of material for a given purpose	compare prioritize convince persuade assess value criticize	justify rank judge decide rate predict argue

Conclusion

Researchers have found that emphasis on higher cognitive questions generally produces better learning than emphasis on factual questions. The preceding charts should be useful to teachers who are beginning to teach thinking skills as an integrated part of subject matter and are testing what they teach.

Reference List:

Bridgeford, N. ed. September 1985. "Thinking Skills: Measuring More Than Recall." CAPTRENDS 10:3 Portland, OR: Center for Performance Assessment, Northwest Regional Educational Laboratory.

Bloom, B. & others. eds. 1956. Taxonomy of Educational Objectives: Cognitive Domain. New York: Davis McKay Co. Inc.

Brooks, M. November 1984. "A Constructivist Approach to Staff Development." *Educational Leadership.*

Falkof, L. & Moss, J. November 1984. "When Teachers Tackle Thinking Skills." *Educational Leadership.*

Marzano, R. & Arredondo, D. 1986. Tactics for Thinking. Aurora, CO: Mid-continent Regional Educational Laboratory.

Paulker, R. 1986. "Teaching Thinking and Reasoning Skills...Problems and Solutions." AASA Critical Issues Report. West Hartford, CN.

Sanders, N. 1966. *Classroom Questions.* New York, NY: Harper and Row.

The lower levels of thinking are prerequisites for higher levels, so that when comprehension is tested, knowledge is also tested; when application is tested, knowledge and comprehension are included, too.

COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a non-segregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

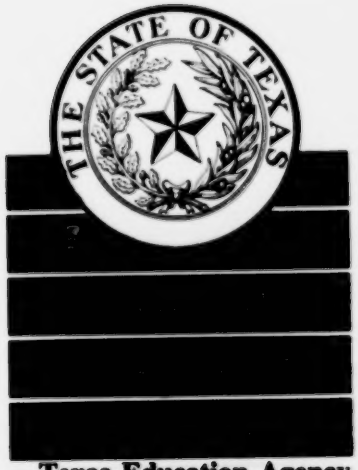
In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, U.S. Department of Education.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared through negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964; EXECUTIVE ORDERS 11246 AND 11375; TITLE IX, 1973 EDUCATION AMENDMENTS; REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; AND VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED IN 1974.

It is the policy of the Texas Education Agency to comply fully with the nondiscrimination provisions of all federal and state laws and regulations by assuring that no person shall be excluded from consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any programs or activities which it operates on the grounds of race, religion, color, national origin, sex, handicap, age, or veteran status (except where age, sex, or handicap constitute a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency makes positive efforts to employ and advance in employment all protected groups.



Texas Education Agency
1701 North Congress Avenue
Austin, Texas 78701
March 1988
GE8 302 02